SENCORE

SERVICE MANUAL

SWEEP & MARKER GENERATOR

SM 152

Electronic Services - Los Angeles
M14966X

SM 152

SWEEP & MARKER GENERATOR

SENCORE

SENCORE SERVICE MANUAL

3200 SENCORE DRIVE, SIOUX FALLS, S DAKOTA 57107

Safety Precautions

When testing electronic equipment, there is always a danger present. Unexpected high voltages can be present at unusual locations in defective equipment. The technician should become familiar with the device that he is working on and observe the following precautions.

1. An isolation transformer should always be used on equipment having the chassis tied to one side of the AC power line.
2. When making test lead connections to high voltage points, remove the power. If this cannot be done, be sure to avoid contact with other equipment or metal objects. Place one hand in your pocket as a safety precaution and stand on an insulated floor to reduce the possibility of shock.
3. Discharge filter capacitors before connecting test leads to them. Capacitors can store a charge that could be dangerous to the technician.
4. Be sure your equipment is in good order. Broken or frayed test leads can be extremely dangerous and can expose the technician to dangerous potentials.
5. Remove the test leads immediately after the test has been completed to reduce the possibility of shock.
6. Do not work alone when working on hazardous circuits. Always have another person close by in case of accident. Remember, even a minor shock can be the cause of a more serious accident, such as falling against the equipment, or coming in contact with high voltages.

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INSTRUCTION MANUAL FOR THE SENCORE SM152 SWEEP AND MARKER GENERATOR

DESCRIPTION

The color television receiver has many critical tuned circuits that must be properly aligned or the set will not give a good color picture that it was designed to do. With the increased production of color TV receivers, it became apparent that a sweep and marker generator that was fast and easy to use, and produced fool-proof outputs was necessary to satisfy field requirements. In the past, sweep alignment has been time consuming and difficult because of the number of pieces of equipment needed and the complexity of the hook up to the TV set before alignment could take place. Sencore engineers have spent considerable time in developing a unique breakthrough in sweep alignment equipment. All the troubles and problems of sweep equipment that have been found in the past, have been eliminated in the SM152. Now, the five pieces of equipment previously needed to do the complete alignment job have been combined into one easy to use, accurate sweep and marker generator. Here are a few of the SM152 features:

- Generates text book response curves through high stability, extremely flat RF output displayed on an ultra linear sweep.
- Complete chroma signal for injection into the IF or chroma bandpass amplifier directly.
- 19 Markers available at the push of a button with a true post injection system.
- 8 crystal controlled markers for the TV IF can be viewed simultaneously or one at a time.
- Sweep direction and response polarity fully controlled to enable the technician to duplicate the illustrations given in the alignment instructions of the different manufacturers.
- Calibrated sweep width and RF output voltage.
- Large 11 inch illuminated dial for easy reading.
- Completely solid state with electronic sweep.
- Three curves are shown on the front panel, RF, IF, and Chroma with marker locations. No need to keep referring to manual for ideal curve shape.

SPECIFICATIONS

RF Output: Variable 10uv to 100mv, flatness + 3 db over all bands; flatness over 15 MHz sweep on 10-55 MHz band +0.3db; 50-120 MHz band ± 0.5db; 110-230 MHz band ± 3 db.

Chroma Output: 0 to 2 volts PP @ chroma jack.

FM IF Output: 10.7 MHz crystal controlled (100uv fixed)

Frequency Coverage: 6 bands
Chroma - 45.75 MHz picture carrier with 42.17 MHz swept subcarrier (3 MHz sweep)
3.58 MHz swept chroma signal available at chroma jack (3 MHz sweep)

IF Spot - 39 MHz - 48 MHz (no sweep) can be checked against eight crystal check points.

10-55 MHz center frequency (0.3-15 MHz sweep)
50-120 MHz center frequency (0.3-15 MHz sweep)
110-230 MHz center frequency (0.3-15 MHz sweep)
440-920 MHz 4th harmonic

Sweep: Calibrated and variable, 0.3-15MHz; linearity 3%; sweep rate 60Hz

Markers (Post Injection System used):
TV IF crystal controlled markers:
39.75, 41.25, 41.67, 42.17, 42.67, 44.25, 45.75, 47.25 MHz

Chroma crystal controlled markers:
3.08, 3.58, 4.08MHz

Sound IF crystal controlled marker:
4.5MHz

TV RF Markers:
Channel 4 (67.25MHz), Channel 5 (77.25MHz)
Channel 10 (193.25MHz), Channel 13 (211.25MHz)

FM IF crystal controlled marker:
10.7MHz plus 10.6 & 10.8 MHz bandwidth markers
External Marker:
75 ohm input (25MV or greater)

SEMICONDUCTOR COMPLEMENT

26 Bi Polar transistors

3 Junction Field Effect Transistors

1 Dual Gate MOSFET

19 Diodes

2 Zener diodes

2 Varicap diodes

OPERATION

CONTROLS ON THE SM152 SWEEP AND MARKER GENERATOR

FIGURE 1
RANGE SWITCH-TUNING AND DIAL OF SM152

RANGE Switch: Selects one of the six different bands of frequencies used for alignment of the TV or FM receiver.

TUNING Control: Selects the desired frequency in each band as selected by the RANGE Switch.

FIGURE 2
SWEEP OUTPUT SECTION OF SM152

OUTPUT Control: The four step coarse attenuator of the RF output voltage; used to select the desired range of output amplitude of the sweep signal.

RF FINE-CHROMA Control: The fine RF output control used in conjunction with the coarse control to vary the output voltage of the SM152. This control also varies the Chroma signal from 0 to 2 volts peak to peak from the CHROMA OUT jack directly below the RF FINE-CHROMA control.

SWEEP WIDTH Control: Varies the sweep width and is calibrated from .3 to 15 MHz

RF OUTPUT Jack: All the sweep signals and RF signals from the SM152 appear at this jack with the exception of the Chroma signal.

CHROMA OUT Jack: The special Chroma signal of 3.58MHz sweep from 2 to 5 MHz is available at this jack.

SWEEP DIRECTION Switch: Controls the direction of the horizontal sweep available from the SCOPE H jack on the SM152. This allows the highest sweep frequency to appear on the left or right of the scope screen.

FIGURE 3
MARKER BUTTONS ON SM152

CRYSTAL CONTROLLED TV IF/CHROMA MARKERS Push buttons: Used to select one or more of the 12 different marker frequencies used in IF and Chroma alignment.

RF MARKERS Push buttons: Used to select one of four RF markers used in tuner alignment and the general overall check.

FM IF MRK Push button: Used to obtain the 10.7 MHz marker and 100 KHz limit markers for use in FM IF alignment or the 10.7 MHz crystal controlled signal for FM IF peaking.

EXT MKR Push button: Is used to select an external marker and is used in conjunction with the EXT MKR IN jack on the lower right of the panel.

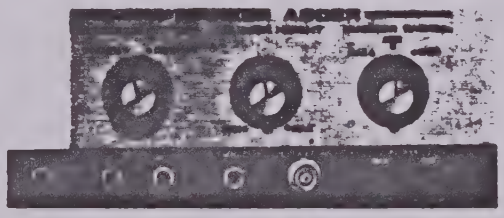


FIGURE 4
MARKER ADDER SECTION OF SM152

RESPONSE PATTERN Switch: Used to select either a positive going or a negative going response curve making the duplication of the response curve on the scope to that of the service literature easier for the technician.

MARKER HEIGHT: A variable control so that the desired height of marker can be placed on the screen according to the users wishes.

MARKER WIDTH Switch: Selects one of three different width markers for use with the different sweep widths in TV and FM alignment.

DETECTOR IN Jack: The signal from the TV or FM receiver is put into this jack with the 39G23 detector probe.

SCOPE V Jack: Provides the response curve and markers to the vertical amplifier of the scope.

SCOPE H Jack: Provides a 60 Hertz horizontal sweep signal for scopes not having an internal line position.

10.7 MHz OUT Jack: Provides a 10.7 MHz crystal controlled signal for FM peaking when the 10.7 MHz marker button is depressed.

POWER Switch: Controls the AC power to the unit.

REAR PANEL CONTROLS

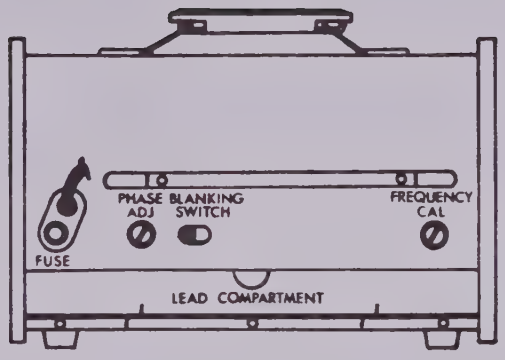


FIGURE 5
REAR VIEW OF SM152

PHASE ADJUST: Adjusts the phase of the horizontal signal to the scope to compensate for phase errors in the scope.

BLANKING SWITCH: Used to eliminate the blanking when adjusting the PHASE ADJUST control.

FREQUENCY CAL: Used to compensate for slight amount of drift in the RF oscillator in the SM152 so that the dial can be set right on frequency.

THREE HUNDRED OHM MATCHING PAD 39G22

The SM152 comes with a special 300 Ohm matching pad, No. 39G22. This pad is used to match the 75 ohm output of the SM152 to the 300 ohm input of TV and FM receivers and to terminate the RF cable to prevent standing waves and distortion of the response curve. If the matching pad is not used when connecting into a 300 ohm input, serious standing waves can result causing the response curve to be tilted and the results will be questionable. If the SM152 is used on a 75 ohm input such as a motel TV receiver or cable system, the RF cable can be used directly without the 39G22 matching pad. When the RF cable is to be connected into a test point, capacitively coupled into the mixer tube, or injected into an IF stage, the 39G22 matching pad is used. The output of the pad is coupled through a capacitor to isolate the RF output circuit of the SM152 from DC voltages.

VIDEO DETECTOR PROBE 39G23

The special video detector probe, NO. 39G23 has a built in isolation resistor and a video detector, making the SM152 complete for all alignment procedures. The Red lead of the 39G23 has a 27,000 ohm resistor between the lead and the input of the SM152 for isolation. The Red lead is connected to the video detector output, audio output of an FM receiver, or the mixer grid test point on a TV tuner to couple the response curve to the marker adder section of the SM152. The isolation resistor prevents loading of the test circuit.

The Blue lead of the 39G23 is the input to the video detector. This lead is used when a demodulator probe is required in the alignment procedure such as at the output of the chroma bandpass amplifier for chroma alignment or the output of the tuner for tuner alignment.

OPERATING THE SM152

The operation of the SM152 has been made so easy and foolproof that even if the instrument is not used for long periods of time, the technician will be able to operate the SM152 with little or no reference to the written procedures. Where possible, signals have been preset internally so that minimum external control is required. A good example is the Chroma signal where the sweep frequency and sweep width are preset and no adjustment of this signal is required. Functionally, the SM152 can be thought of as four separate sections combined into one instrument: 1. Frequency selection, 2. Sweep output control, 3. Marker Adder, and 4. Marker Selection. Let's follow through the operation of the SM152 and see how each section is operated to obtain a response curve from a television receiver.

1. FREQUENCY SELECTION

The RANGE switch on the SM152 is used to select one of the six different bands of frequencies used in sweep alignment. The bands are; CHROMA, a 2 to 5 MHz swept signal for injection directly into the bandpass amplifier and a 42.17 MHz swept signal modulating a 45.75 MHz video carrier for injection into the TV IF system; an IF spot align band from 39 to 48 MHz that is not swept, for setting of the traps and spot alignment of the IFs in older TV receivers; a 10 to 55 MHz band to cover the TV and FM IF frequencies; a 50 to 120 MHz band to cover TV channels 2 to 6 and the FM band; a 110 to 230 MHz band to cover TV channels 7 to 13; and a 440 to 920 MHz band to cover the UHF TV channels. The Tuning control is used to dial the desired frequency in each band; it has no effect on the fixed Chroma signals when the RANGE switch is in the CHROMA position. The frequency selected is the center frequency of the swept band. For example, when the IF of a TV receiver is to be swept, the TUNING control would be set for about 43 MHz. The swept signal will go equally above and below this point. If the SWEEP WIDTH control is then set for a 10 MHz sweep width, the signal will go 5 MHz above and 5 MHz below 43 MHz or be swept from 38 to 48 MHz. If an RF frequency were chosen, the pointer would be set to the center of the channel number as marked on the dial.

2. SWEEP OUTPUT CONTROL

Once the desired frequency has been selected with the RANGE switch and TUNING control, the amplitude and width of the signal must be set. The output voltage amplitude is controlled by the OUTPUT control which is a coarse four step attenuator and the RF FINE-CHROMA control which is the fine attenuator. The coarse control is a four step attenuator with 20 db steps of 100, 1K, 10K, and 100K microvolts. In any position of the OUTPUT control, the RF FINE-CHROMA will vary the signal approximately 20 db. In the 100 microvolt position, the RF FINE will change the signal from 10 microvolts at the minimum position to 100 microvolts at the maximum position. In the 1K position it varies from 100 to 1000 microvolts, in the 10K position from 1000 to 10,000 microvolts, and in the 100K position from 10,000 to 100,000 microvolts. When doing tuner alignment or when making an overall check, the OUTPUT control will generally be set to the 1K range. For IF alignment, the setting will depend upon the method used to couple the signal; Capacity coupled into the mixer shield or injected into the test point. For injection into the test point, the 1K range will normally be used and when capacity coupled into the mixer tube, the 100K range will be used. In FM alignment, the amplifiers are more sensitive and the 100 microvolt range will be used for injection into the antenna terminals, and the 1K range will be used for IF alignment.

Once the sweep output has been set, then the sweep width should be set. The SWEEP WIDTH control is variable and calibrated from 0.3 to 15 MHz. When the desired frequency is selected, the sweep width must be determined and the control set ac-

cordingly. When sweeping the tuner, the sweep width is normally set to 10 MHz giving a 5 MHz swept signal above and below the desired frequency. For TV IF alignment, the sweep should be set to about 8 MHz so that all the traps can be seen. In FM, the lowest limit of 0.3 MHz will be required. The sweep width control can also be used to expand a portion of the response curve, such as the color slope in a color TV receiver so that the important points can be set correctly. Simply adjust the TUNING control to center the portion of the curve that you are interested in on the scope screen and then reduce the sweep width to expand the sweep. The sweep width control does not effect the Chroma signal, which is preset, or the IF spot align band where there is no sweep. The sweep width obtained on the 10-55, 50-120 and 110-230 MHz bands is that marked on the front panel. On UHF, the fourth harmonic of the 110 to 230 MHz band is used and the sweep width will be four times that marked on the front panel.

If the direction of the sweep is opposite to that shown in the alignment procedure or not to the liking of the technician, it can be changed with the SWEEP DIRECTION switch. If the low frequencies are on the right side of the scope screen and the manufacturers literature show them on the left, simply set the SWEEP DIRECTION switch to the opposite position and the direction of the sweep will reverse, matching the display with the literature. If the signal from the SCOPE H jack on the SM152 is not used to drive the scope, the SWEEP DIRECTION switch will not affect the direction of the response curve. To reverse the direction of sweep when you do not use this signal, simply reverse the plug on the scope.

The RF cable with the 39G22 matching pad is used to couple signals from the RF OUTPUT jack on the SM152 into the receiver being aligned. The RF jack is used for all signals from the SM152 with the exception of the 2 to 5 MHz swept Chroma signal, and the 10.7 MHz crystal signal. The 10.7 MHz signal, available from the 10.7 MHz OUT jack near the POWER switch has a fixed level of 100 microvolts used for FM peaking. The Chroma signal from the CHROMA OUT jack is variable from 0 to 2 volts peak to peak and is controlled with the RF FINE-CHROMA control. The Chroma signal is used for direct injection into the bandpass amplifier for alignment of this section of the color receiver as recommended by some manufacturers, or for trouble shooting of the bandpass amplifier when a loss of gain or signal is experienced.

3. MARKER ADDER

With the RF cable connected to the antenna terminals or the injection test point and the RF output and sweep width set, the response curve from the set must now be coupled into the marker adder where the markers will be added. The 39G23 detector cable is used for this purpose, and is connected to the DETECTOR IN jack on the lower part of the SM152 panel. The red lead with a built in isolation resistor is connected to the detector load when observing the IF response, or the blue lead with the built in detector is connected to the output of the chroma amplifier when observing the bandpass response. The vertical input of the scope is connected to the SCOPE V jack so that the response curve can be displayed on the scope screen. The SCOPE H jack is connected to the horizontal input of the scope if no LINE position is available on the scope or the SWEEP DIRECTION switch on the SM152 is to be used. If the response curve is not of the polarity of that shown in the service literature, simply set the RESPONSE PATTERN switch to the opposite setting to change the polarity of the response curve on the scope screen.

4. MARKER SELECTION

After the response curve is obtained on the scope screen, markers are added to determine the exact points on the response of critical frequencies. With push button

selection, this is as simple as depressing a button under the desired frequency. For TV IF, the markers are crystal controlled and cover all the necessary check points; 39.75 for adjacent video traps, 41.25 for the sound traps, 41.67 and 42.67 for the color limit markers, 42.17 for the color carrier, 44.25 for the central portion of the curve, 45.75 for the video carrier, and 47.25 for the adjacent sound traps. When the Chroma signal is injected into the IF, the 41.67, 42.17, and 42.67 markers are used and become 4.08, 3.58, and 3.08 on the response curve when viewed at the chroma bandpass amplifier. When the IF response is viewed at the video detector, the markers are as listed on the front panel. When the chroma signal is injected directly into the chroma bandpass amplifier, the markers are 3.08, 3.58, and 4.08 as marked on the front panel. Both frequencies are activated when the signal button is depressed, thereby simplifying operation and eliminating confusion. For tuner alignment, the four most recommended markers are available, one at a time. Channels 4 and 5 are available when the RANGE switch is set to the 50 to 120 MHz band and Channels 10 and 13 are available when the RANGE switch is set to the 110 to 230 MHz band. A 10.7 MHz marker is available for FM alignment. This marker has automatic 100 KHz limit markers of 10.6 and 10.8 MHz so that the band width of the FM IF can be determined. This 10.7 MHz crystal controlled signal without the limit markers or sweep is available at the 10.7 MHz jack on the lower panel for peaking of monophonic FM IFs. If markers other than those provided are desired, the signal may be injected from an external marker or signal generator into the EXT MKR IN jack on the lower panel. When the EXT MKR button is depressed, the marker will appear on the response curve.

The TV IF marker switches and the FM IF and EXT marker switches are push-push type; Push to make, push to break. The RF marker switches are interlocked so that only one RF Marker is available at a time.

The amplitude of the markers is variable so that the desired size marker may be put on the response curve with the MARKER HEIGHT control. The setting of this control will not affect the response curve in any way as the marker is post injected, i.e.; merely added to the response. The marker width is also variable so that depending upon the sweep width, the desired size can be obtained. Three sizes are available, NAR or narrow for narrow sweeps such as in FM IF alignment, MED or medium for chroma bandpass alignment and WIDE for Tuner and TV IF alignment. Of course, the user can select his choice for any alignment procedure if he desires.

REAR PANEL CONTROLS

There are three controls on the rear of the SM152 that will seldom be used. These are the BLANKING switch, the PHASE ADJUST, and the FREQUENCY CAL. The location of these controls is shown in figure 5.

The PHASE ADJUST will normally be set once for the scope used, and then not touched again unless the scope is changed. To adjust the PHASE ADJUST, the BLANKING switch is pushed to the unblanking position. It is a spring loaded switch and will return to the blanking position the moment it is released. If two waveforms are seen on the scope screen as shown in figure 6, set the PHASE ADJUST control until they fall on top of each other or are in phase. Then release the BLANKING switch. If the horizontal line position of the scope is used for horizontal trace, the PHASE ADJUST on the SM152 will not have any affect. The phase adjustment on the scope must be used to phase the two waveforms using the BLANKING switch on the SM152 the same as was done for the PHASE ADJUST on the SM152.

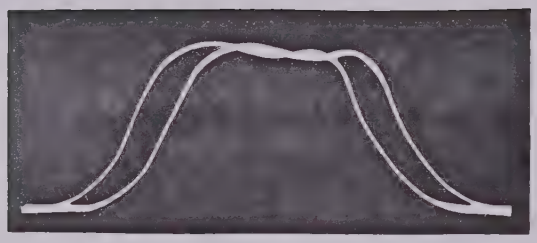


FIGURE 6. RESPONSE CURVE OUT OF PHASE WITH BLANKING REMOVED.

If the RF frequency of the sweep generator drifts slightly, it can be put back on frequency with the FREQUENCY CAL control. The control is easily adjusted using the internal markers of the SM152 as a check point. For example, the RANGE switch can be set to the 10 to 55 MHz band and the 45.75 marker button depressed. Then set the tuning dial to the 45.75 point marked on the dial. With the scope connected as for sweep alignment, but no detector input to the SM152, adjust the FINE RF ADJUST until the marker seen on the base line on the scope screen is in the center of the screen. You will have to adjust the sweep width, marker height and marker width to get the desired size marker on the screen. This control will seldom be used, but the accuracy of the dial markings can be checked using the above method.

APPLICATIONS

WHAT IS SWEEP ALIGNMENT

A tuned amplifier, such as the IF amplifier in a television receiver, is designed to pass a band of frequencies and reject frequencies outside of this band. For example a color television IF amplifier is designed to pass frequencies between 41.67 and 46.75 MHz and reject frequencies below 41.25 and above 47.25 MHz. This wide pass band is obtained by having several IF stages each tuned to a different part of the band, i.e.; stagger tuned. Alignment of this amplifier with a standard signal generator is difficult, because each stage has to be aligned individually and then the overall response checked by laboriously recording the output as input frequency is changed in small steps across the band. Plotting output against frequency on a graph would then show the response of the amplifier.

If you were able to tune the frequency of the signal generator at an even rate back and forth across the frequency band of interest you could observe the output (after detection) on an oscilloscope and actually see the response of the amplifier. This is what is done in a sweep generator. The output signal from the generator is a constantly changing frequency over a selected range as determined by tuning and the sweep width settings of the generator. The rate at which the output is swept is low, generally for convenience, the frequency of the AC line.

Markers are added to the response curve to accurately show the frequency at different parts of the curve. They are generated by amplifying the low frequencies on each side of the zero beat that develops when the frequency of the sweep signal passes through the marker oscillator frequency. Generating markers external to the amplifier under test and adding them to the response curve is called post injection. It is superior to a preinjection system where the marker oscillator signal is fed to the amplifier under test along with the sweep signal. Markers developed this way can distort the response curve or are lost in traps making sweep alignment more difficult.

THE COLOR TV I.F. RESPONSE CURVE

The ideal color TV IF response curve is shown in figure 7. It is also shown on the front panel. You should become totally familiar with this curve, because it can be an excellent trouble shooting aid. Note that the top of the curve shown is flat. However, some sets will have a dip in the top; and others the(newer color sets)have a rounded or "hay stack" top.

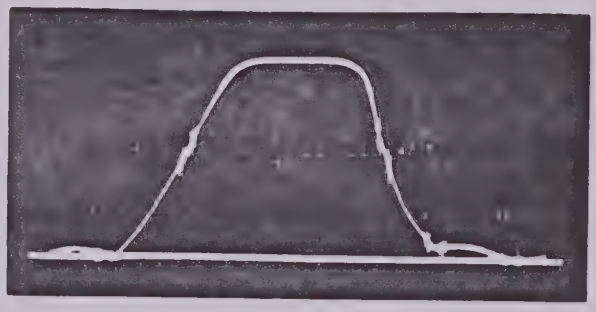


FIGURE 7 IDEAL RESPONSE CURVE OF TV RECEIVER

The shape of the response curve skirts is very important. The picture carrier (45.75 MHz) and the color sub carrier (42.17 MHz) are approximately at the 50 percent points on the skirts. Color signal information 0.5 MHz away (41.67 MHz) must still pass through the amplifier, but the sound carrier (41.25 MHz) must be trapped out so this skirt has a fairly steep slope. The opposite slope is not quite as steep, but should rise linearily for best recovery of low frequency video information. The upper adjacent channel picture carrier (39.75 MHz) and the lower adjacent channel sound carrier (47.25 MHz) must be trapped out to prevent interference. The amplifier has minimum or zero gain at these frequencies.

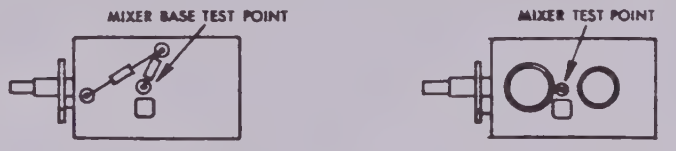
There are a number of things that will affect the response curve. If a trap is misadjusted for example, it will be impossible to get the correct curve and a lot of time can be wasted if this is not recognized. One or more weak stages will also give a poor curve so the tubes should always be checked or substituted before alignment is attempted. The design of an amplifier takes into account the internal tube capacity. When tubes are replaced in an amplifier a different internal capacity could upset the alignment. Study the curve in Figure 7. When you know how the curve should look you will be able to pin-point troubles fast.

CONNECTING THE SM152 FOR ALIGNMENT

The SM152 is extremely easy to connect and will require only three cables for the total alignment of a color television receiver. How to connect these cables is covered in the section below:

RF CABLE: The RF cable is connected to the antenna terminals, the mixer tube in the tuner, or to the individual IF stages depending upon the alignment instructions of the particular manufacturer. The 39G22 matching pad is used in most cases as it not only acts as a 300 ohm match for the antenna terminals found on the TV set or FM tuner, but terminates the cable so that no standing waves are present. When using the RF frequencies of channel 2 and above for TV or 88 to 108 for FM, the RF cable is connected to the antenna terminals of the set. If TV IF alignment is being performed, the RF cable with the 39G22 matching pad connected is either connected to

the mixer test point or capacity coupled to the mixer tube. The test point is easy to find as it is located next to a square hole in the tuner. Figure 8 shows this location on a tube type tuner. On some solid state tuners, the test point is on top of the tuner as in the tube model, and in others it is located on the side of the tuner.



TYPICAL TRANSISTOR TUNER TEST POINT LOCATION

TYPICAL TUBE TYPE TUNER TEST POINT LOCATION

FIGURE 8

To capacity couple to the mixer tube, you can use an ungrounded tube shield in the older tuners, or use a conductive foil wrapped around the mixer tube when the shield is not removable. The foil should be covered with tape to prevent it shorting to the shield. In either case, the hot lead of the 39G22 matching pad is connected to the shield or foil and the other lead to ground. When using the 39G22 matching pad for injection of the IF signal into individual stages, a capacitor is not needed as it is already built into the matching pad. The 39G22 matching pad is not used when matching into 75 ohm systems. The DETECTOR CABLE is connected from the SM152 DETECTOR IN jack to the various points as described in the individual alignment procedures that follow. The Scope Vertical input cable is connected from the SCOPE V jack on the SM152 to the vertical input of the scope. The SCOPE H jack may also be used if the scope has no line position on the horizontal amplifier.

DETERMINING THE ACCURACY OF THE SCOPE FOR SWEEP ALIGNMENT

The oscilloscope is an important tool in sweep alignment. If the scope does not have a good low frequency response, has a phase shift in the vertical amplifier, or a phase shift between the horizontal and vertical amplifier, the response curve on the scope screen can be misleading as to the actual condition of the television receiver. Any of the above conditions can distort the response curve enough to give inaccurate results when the TV set is aligned. The Sencore SM152 has an ultra linear sweep and a flat automatically controlled output and can be used to check out the scope before any alignment is started. If the scope is checked out, the results can be taken into consideration when doing the alignment for a more precise job.
To make the accuracy check with the SM152 on your scope, follow these steps:

1. Set the SM152 to the 10-55 MHz range and the tuning dial to about 43 Megahertz. Set sweep width to 15 Megahertz.

2. Connect the RF cable using the 300 ohm matching pad to the detector probe (blue lead) input and the scope vertical input to the SCOPE V jack on the SM152.

3. Adjust the scope vertical gain until a usable pattern is seen. If the scope is good and has no phase shift and has a good low frequency response, the pattern should appear as shown in figure 9.

If the scope has a poor low frequency response, the pattern will appear as shown in figure 10. The more the pattern bows or tilts the worse the low frequency response is. Some bowing or tilting of the pattern will be acceptable and should be taken into consideration when adjusting the television receiver. Figures 11 and 12 show other various scope troubles. If any of these problems appear to excess, it will affect the response curve of the TV set.

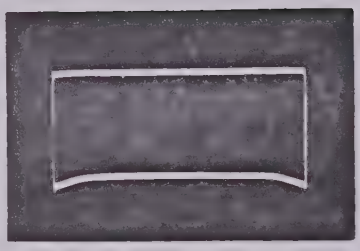


FIGURE 9. FLAT SCOPE RESPONSE.

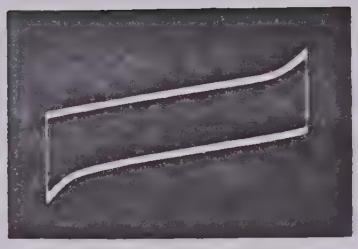


FIGURE 10. POOR VERTICAL LOW FREQUENCY RESPONSE.

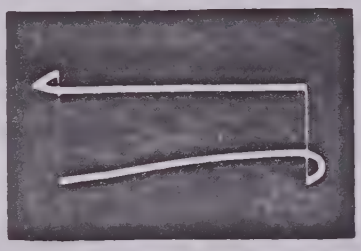


FIGURE 11. PHASE SHIFT IN THE HORIZONTAL AMP.

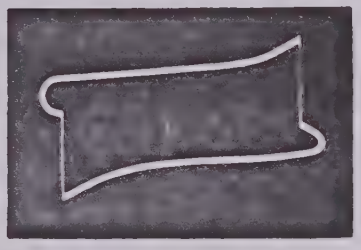


FIGURE 12. PHASE SHIFT AND POOR LOW FREQUENCY RESPONSE.

The signal at the SCOPE H jack is about 60V P-P behind 1 megohm. This voltage is high enough to provide adequate horizontal drive for almost any scope, but may overload some scopes. Overload of the horizontal amplifier of your scope may be avoided by shunting the horizontal input terminals with a suitable resistor. Simply turn your horizontal gain control down about 1/3 from maximum gain, and try a few values of shunt resistor until you find one which gives about full screen deflection. For the Sencore PS148, a suitable value would be about 330K. After the resistor is connected, the HORIZONTAL PHASE adjustment on the rear of your SM152 must be reset in accordance with the instructions in the section OPERATING THE SM152 under the paragraph REAR PANEL CONTROLS.

OVERALL ALIGNMENT CHECK WITH THE SM152

An overall alignment check should be made when the alignment of the television receiver is in question, or as a general procedure to insure your customer the best possible picture. The overall procedure outlined below will check the tuner and IF amplifiers from the antenna terminals to the video detector. If there is any misalignment or other troubles, they will show up on this check. Connect as shown in figure 13.

To make the overall alignment check with the SM152 proceed as follows:

1. Connect the RF cable terminated with the 39G22 matching pad from the SM152 RF OUT jack to the antenna terminals of the television receiver.
2. Set the SM152 Range switch to the 110-230 MHz range and the TUNING control to the center of channel 10. Set the TV tuner to channel 10 also.
3. Connect the 39G23 detector probe Red lead to the video detector load resistor or the grid of the first video amplifier. In many TV receivers, there is a terminal at the top of the chassis for the detector and AGC test point. The other end of the detector cable should be connected to the DETECTOR input jack on the front panel of the SM152.

4. Apply a bias to the IF and tuner AGC test points. Some manufacturers recommend shorting the IF AGC to ground. Be sure to check the manufacturers literature. A negative two volt bias is used on the tuner in tube receivers. Solid state receivers use positive or negative bias depending on the type of transistor used and if forward or reverse AGC is used.

5. Connect the scope vertical input to the SCOPE V jack on the front panel and the scope horizontal input to the SCOPE H jack on the front panel. The scope vertical sensitivity should be set so that a two volt peak to peak signal will give two inches of vertical deflection. A two volt signal from the video detector is a good average output to maintain during alignment.

6. Set the OUTPUT control on the 1K range and the RF FINE-CHROMA to MAX. This should give about 2 volts peak to peak at the video detector under normal conditions. If the OUTPUT control must be switched to the 10K range, then a loss of gain in the tuner or IF is indicated.

7. Depress the CH10 marker button and adjust the fine tuning control of the television receiver until the marker rests on the 50% point of the response curve as shown in figure 14. Depress the 3.58 marker button. The marker should fall at the 50% point on the opposite end of the curve as shown in figure 14.

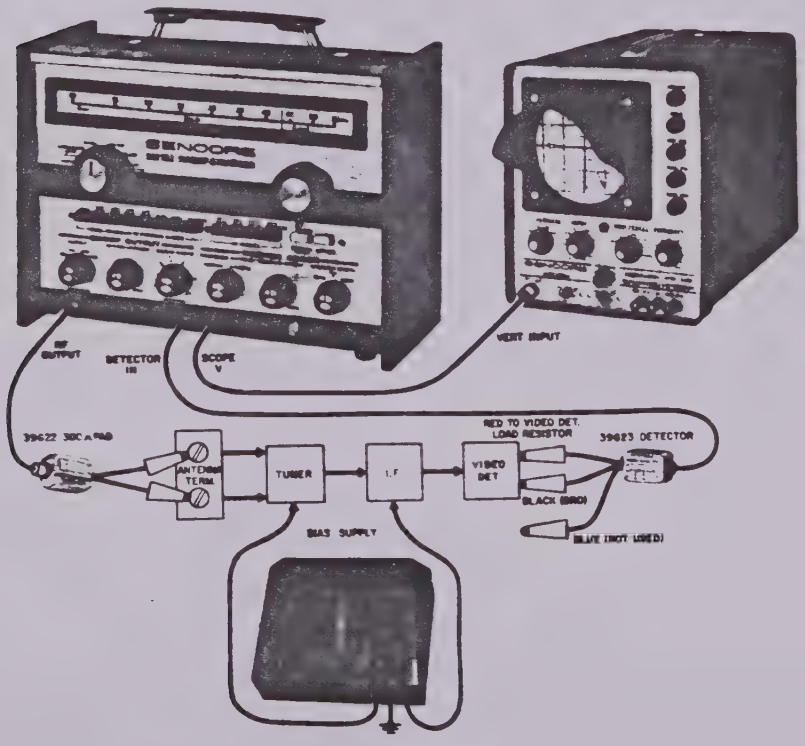


FIGURE 13

CONNECTING FOR OVERALL ALIGNMENT CHECK

NOTE: Both the upper and lower side bands of the color carrier are present in the marker system and it is possible to mis-tune the TV to the lower side band. To insure that you are tuned properly do the following: Tune the channel 10 marker to the center of the screen. Increase the frequency from the SM152 by turning the TUNING control clockwise. The channel 10 marker should move to the left. If not, reverse the SWEEP DIRECTION switch. The TV can then be properly tuned by placing the channel 10 marker on the left skirt of the response curve.

If the overall response curve is not as shown in figure 14, then the television receiver is in need of alignment. The stages that are most likely to be off are the IF amplifiers. If the overall alignment is off, proceed with the IF alignment check.

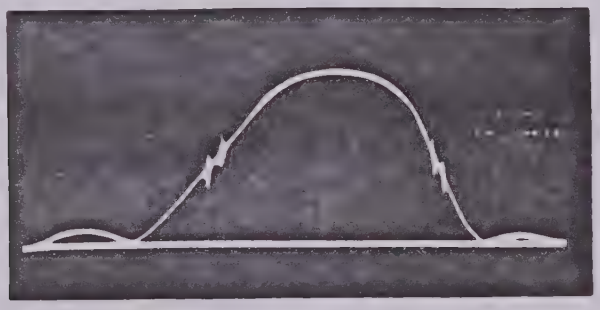


FIGURE 14. OVERALL RESPONSE CURVE.

If the response curve shown on the scope screen is not of the same polarity as shown in the service literature, turn the RESPONSE PATTERN switch to the opposite setting. This will reverse the polarity of the response curve as seen on the scope screen.

I.F. RESPONSE CURVE CHECK

The IF amplifiers of the television receiver are the most critical amplifiers in the set. Most of the variations of the overall response curve will be the result of changes in the IF amplifiers. Tube capacity differs from tube to tube so that when a new tube is replaced in the IF, the response curve will change. To make a quick check of the IF response, follow these simple steps:

1. Use the 39G22 matching pad and connect the RF cable to the mixer test point or capacity couple into the mixer tube as described in "CONNECTING THE SM152 FOR ALIGNMENT".

2. Connect the red lead of the 39G23 detector probe to the video detector load resistor or grid of the first video amplifier.

3. Connect the scope vertical input to the SCOPE V jack on the front panel of the SM152.

4. Connect a bias supply to the IF AGC test point. If you do not have a schematic follow the grid load resistor and connect the negative lead of the supply to the end of this resistor. If the IF is solid state, find the base resistor and connect the bias supply to the end opposite the base end. In tube receivers, a negative 2 to 3 volts is normally used, and in solid state receivers a positive voltage will be normal. The amount of voltage should be taken from the service literature.

5. Disable the VHF tuner by setting it between channels, or if there is no UHF tuner on the set, the VHF tuner can be disabled by setting it on the UHF position.

6. Set the SM152 Range switch to the 10 to 50 MHz range and tune for an output center frequency of 43 MHz. Set the SWEEP WIDTH control to 8 MHz.

7. Adjust the RF OUTPUT and RF FINE-CHROMA controls until you have about a 2 volt peak to peak response curve. The RESPONSE POLARITY control may be switched so that the curve is either positive or negative going to correspond with the service literature you are using.

8. Depress the 45.75 and the 42.17 markers and adjust the MARKER HEIGHT control until the markers are to your liking. The MARKER WIDTH control should be set to the WIDE position.

The response curve should appear as shown in figure 7. Note that this is a flat topped curve and that some of the later model sets will have a "Haystack" or rounded top curve. In both cases, the video and color carriers will fall at the 50% points on the curve for the best alignment. The IF response curve with all the marker locations is also shown on the front panel for quick, easy reference.

You can depress the trap and color sideband limit markers at this time so that all eight markers are visible on the curve to completely check out the alignment of the TV receiver. The traps should be at the baseline indicating a minimum gain and the color side band limits should fall as shown in figure 15. Note: If the vertical scope gain is increased greatly the traps can be easily seen and accurately set. The best procedure to follow in the alignment of the IF and other tuned circuits of the television receiver are those of the manufacturer. Each manufacturer has a different method of getting the overall response curve out of the RF and IF systems. Some sets are aligned stage by stage while others may have the fourth IF transformer preadjusted, with the remaining transformers touched up on the overall curve for best results.

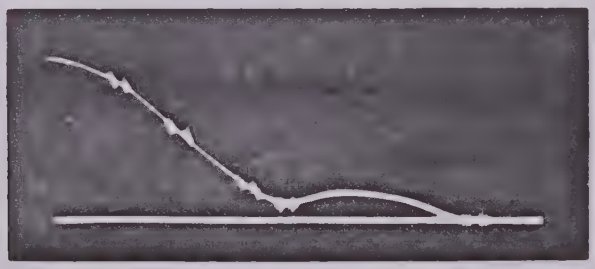


FIGURE 15 COLOR PORTION OF RESPONSE CURVE

In solid state, many new innovations such as bridged T filters are being used in the IF stages to obtain the proper bandpass response. In most cases, the solid state IF system will have a broader bandpass and the traps will be sharper, also you may find more traps in the system.

INTERFERENCE ON THE RESPONSE CURVE

Hash and interference on the response curve can be caused by both the horizontal output circuit and the vertical circuit radiating. The horizontal output tube will cause a hash or grass on the overall curve as shown in figure 16 while the vertical circuit

will cause a spike to drift through the response curve and cause distortion. The following describes how each type of interference can be eliminated.

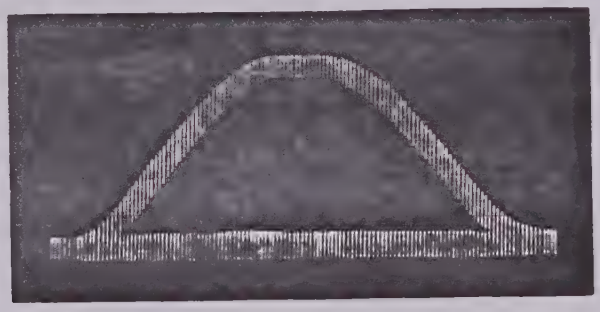


FIGURE 16
HORIZONTAL INTERFERENCE CAUSED BY OUTPUT TUBE

Horizontal Output Tube Radiation: One of the easiest ways to remove the horizontal output radiation is to remove the horizontal output tube from its socket. Do NOT merely take the cap off, because in some circuits, the screen of the output tube will be destroyed. In a series string type receiver, it is very difficult to take the tube out without disrupting the entire set, unless a dummy tube or resistor is put in its place. A very handy and easy way is to use the Sencore RC146 Handy 75 power resistor section of 20 values at 20 watts and connect the output of this section across the filament pins of the tube socket. If it is a compactron, the filament pins are 1 and 12 and if it is a novar, pins 4 and 5. There may be a tube or two with variations of this, but these are the most common filament pins. Consult a tube manual or the set schematic if in doubt. With the Handy 75 connected to the filament pins, connect a volt meter across the filament pins and adjust the selector switch with the TV set on to provide a voltage drop equal to the filament voltage of the tube.

Vertical Circuit Interference: Interference from the vertical circuits is generally a spike that will drift through the response curve and cause distortion as it passes through. This is created because of the slight difference in frequency between the vertical frequency of the set and that of the sweep generator. In many cases, the vertical hold control can be adjusted to lock the spike in at the end of the response curve where it is out of the way. Some sets have a "set up" switch. This switch can disable the vertical deflection system, eliminating the vertical interference.

SENCORE SIMPLIFIED PROCEDURE FOR I.F. ALIGNMENT

There are cases when no information is available on the particular set that you are working on and it is in need of alignment. If you just diddle the IF slugs to try and get the correct response curve, you can get yourself into a lot of trouble. Adjusting the wrong slug to get the end of the response curve up, for example, may cause a dip in the center or at the other end of the curve leading to a poor overall response curve.

When no information is available, the following procedure can be used and will work on many color receivers using a three tube IF system. This system will not work in solid state IFs and the manufacturer's procedure should be followed.

1. Connect the SM152 RF cable with the matching pad attached to the tuner "test" point or capacity couple to the mixer tube as previously described.

2. Set the Range switch on the SM152 to the 10-55 megahertz range and the TUNING dial to about 43 megahertz.

3. Connect the 39G23 probe red isolation lead to the video detector load or the grid of the first video amplifier.

4. Connect the scope V and H jacks to the vertical and horizontal inputs of the scope.

5. Connect a bias supply such as the Sencore BE113 to the AGC test point. If you do not know where that is, find the grid of the first IF amplifier and connect to the bottom of the grid load resistor. Use about 2 to 3 volts negative on tube sets. If in doubt, measure the AGC point with the set operating to find the polarity of voltage required.

6. Disable the tuner by setting it between channels or setting it to UHF if no UHF tuner is used.

7. Adjust the RF COARSE and RF FINE for a two volt peak to peak response curve on the scope screen.

Now check to see where the response curve is down and which part needs alignment. Figure 17 shows the different frequencies that are controlled by the IF transformers in the three stage color IF system. Note that the mixer plate coil will have a greater effect on the overall tilt of the response curve and that the first IF transformer has more effect on the overall gain. If the curve is down at the picture carrier end, the second IF transformer needs adjustment; and if the curve is down at the color carrier end, the third IF transformer is the one to adjust.

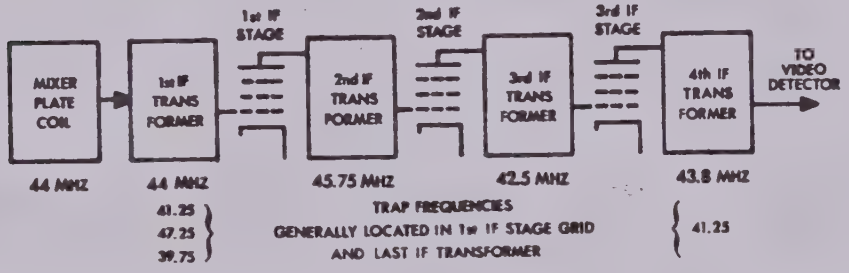


FIGURE 17. FREQUENCIES CONTROLLED BY IF TRANSFORMERS IN 3 STAGE IF SYSTEM IN THE COLOR RECEIVER.

Be sure that the traps are adjusted properly before touching up the overall response curve. If a trap is off far enough, it will cause a dip or drop in the response curve. To check out the traps, depress the trap marker buttons on the front panel of the SM152. The markers should fall on the response curve as shown in figure 18. If they do not fall at the dips of the curve as shown, adjust the trap adjustments until all the traps fall into the dips as shown in figure 18.

You will find that if you have replaced the first IF tube, the first and second IF transformers will require a touch up. If the second IF tube is replaced, the second and third IF transformers will require a touch up; and if the third IF tube is replaced, the third and fourth IF transformers will require a touch up. If no tube has been replaced, figure 17 can be used to find the transformer that will require a touch up to bring the curve back into its proper shape.

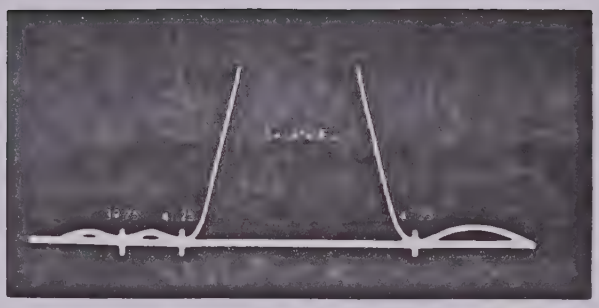


FIGURE 18 LOCATION OF TRAPS ON RESPONSE CURVE

A good point to remember is to use the video and color carrier markers when making the touch up adjustments. If you do this, you will be sure that you are not shifting the carrier points above or below their respective 50 percent points on the curve.

CHROMA BANDPASS ALIGNMENT USING A SIGNAL THROUGH THE I.F.

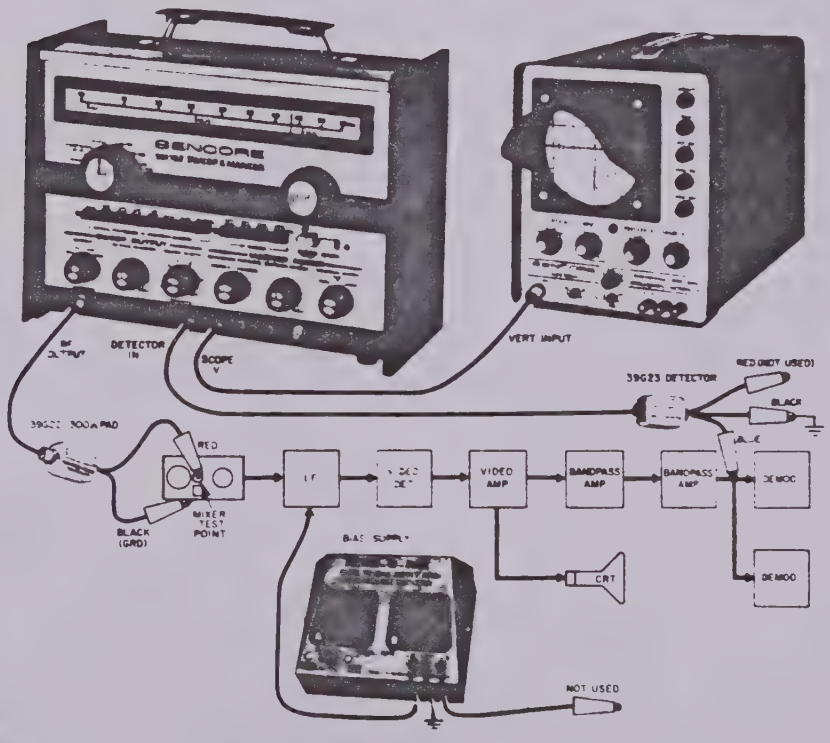


FIGURE 19

CONNECTING FOR BANDPASS ALIGNMENT THROUGH THE VIDEO I.F.

Color signal information is amplified unequally as it passes through the IF amplifier, because the color subcarrier is at the 50 percent point on the response curve skirt. The bandpass amplifier must make up for this condition by amplifying the color signal information unequally in the opposite direction, so that the net effect is equal amplification of the entire color signal. The only way that the bandpass amplifier can be aligned easily is to feed a special signal through the IF and observe the bandpass response at the output of the bandpass amplifier. See Figure 19. The SM152 provides this necessary signal when the RANGE switch is set to the CHROMA position. Note: It is very important that the IF response is aligned first, because good alignment of the bandpass amplifier depends on proper IF alignment.

After the IF has been aligned or checked, simply turn the RANGE switch to the CHROMA position and connect the Blue lead of the 39G23 detector probe to the output of the bandpass amplifier and you are set to check out and align the chroma section of the receiver. Frequency and sweep width are preset in the CHROMA position. Follow these simple steps:

1. Connect the 39G22 matching pad to the tuner test point (see figure 8) or capacity couple to the mixer tube as described in "CONNECTING THE SM152 FOR ALIGNMENT.

2. Connect the Blue lead of the 39G23 detector probe to the output of the bandpass amplifier, or to the cathode of one of the demodulators.

3. Connect a bias supply to the IF AGC test point. A positive voltage is needed if the set is solid state and a negative voltage for a tube set. In some cases, the manufacturer will tell you to ground out the AGC test point in a tube receiver. This also will hold true for the chroma alignment.

4. Disable the tuner by placing it between channels or switching to UHF if no UHF tuner is used.

5. Set the RF output on the SM152 as you would for IF alignment. A two volt peak to peak response curve is normal with most sets. If you are working on a Zenith receiver, it should have at least a 4 to 6 volt peak to peak response curve for the best alignment.

6. The scope vertical input should now be connected to the SCOPE V jack on the SM152 and the scope set to LINE for a 60 Hertz sweep, or use the SCOPE H signal from the SM152. Adjust the scope controls for a proper trace.

The best procedure for alignment of the chroma is to follow the manufacturer's service procedure. The overall curve should appear as shown in figure 20. It is also shown on the front panel. Note that the 3.08 and 4.08 markers should be equally spaced and appear at the 80% points on the curve. In many sets, an automatic 3.58 marker will appear on the curve due to the 3.58 crystal in the set.

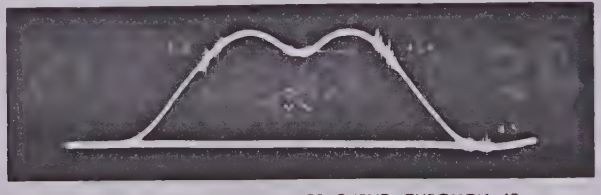


FIG. 20 CHROMA BANDPASS CURVE THROUGH IF

In most cases, the chroma take off coil is peaked at 3.58 MHz for maximum gain while the second and third transformers will affect the 3.08 and 4.08 marker positions on the curve respectively. This will not always hold true, so check the manufacturers literature for their recommended procedure.

CHROMA BANDPASS AMPLIFIER ALIGNMENT DIRECT

Several manufacturer's procedures call for alignment and checking of the chroma bandpass amplifiers by injecting a swept chroma signal directly into the bandpass amplifiers. This signal will be used mostly with older color sets, where the color signal information is amplified equally in the IF amplifier and in the bandpass amplifier. However, on newer sets if the bandpass alignment seens to be way off it is helpful to get close by sweeping the bandpass directly before using the procedure in the preceeding section. This signal is available from the CHROMA OUT jack on the front panel of the SM152 when the RANGE switch is in the CHROMA position. The 0 to 2 volts peak to peak signal is controlled by the RF FINE-CHROMA control. The procedure for alignment of the chroma bandpass amplifier directly is as follows:

1. Connect a lead from the CHROMA OUT jack on the SM152 (red lead) to the video detector output, or to the point that the chroma signal is taken off in the set. Set the Range switch to CHROMA.

2. Connect the Blue lead of the 39G23 detector probe to the output of the bandpass amplifier or the cathode of one of the demodulators.

3. Connect the scope vertical input to the SCOPE V jack on the SM152.

4. Connect a bias supply to the AGC test point and adjust to cut off the IF to prevent noise or interference, or pull the last IF tube.

The response curve will generally appear like that shown in figure 21. This unequal response curve is due to the unequal amplification of the chroma signal in the IF stages. If the color slope of the IF response curve is off or the chroma bandpass curve is off, the results may not appear as shown in figure 20. This would then result in an unequal amplification of certain colors. If the chroma bandpass is aligned by itself, it is best to check the overall curve as described in "CHROMA BANDPASS AMPLIFIER ALIGNMENT THROUGH THE IF" as a last step to be sure of a flat overall response for best color.

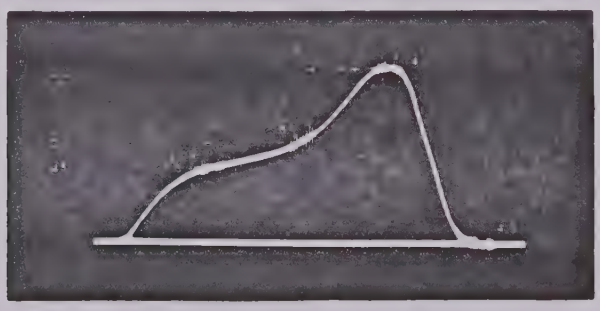


FIG. 21 CHOMA BANDPASS CURVE OF BANDPASS AMPLIFIER ONLY

VIDEO SWEEP CHECK (VSM) WITH THE SM152

The CHROMA signal from the SM152 can be used to check the high frequency response of the video amplifier in a television receiver. Simply feed the CHROMA OUT signal to the input of the first video stage. A wide band scope or the detector probe can be used to trace the signal through the video amplifiers. If the wide band scope is used, the waveform in figure 22 will result. The scope horizontal is set to line position or the SCOPE H signal from the SM152 can be used. If the detector probe is used, a regular response curve will result. The sweep width of the chroma section is fixed and will not give a sweep from zero. If you wish a wider sweep to cover from zero (0) to about 5 MHz, you can make a simple change in the SM152. Use a 10K resistor and parallel R356 found on the control board 43B15. This will increase the sweep width of the chroma signal from the SM152 to that shown in figure 23 as observed with a sensitive wide band scope and the 39G23 detector probe. After adding the 10K resistor it will be necessary to readjust the internal sweep width and phase adjustment as described under the Maintenance section of the manual.

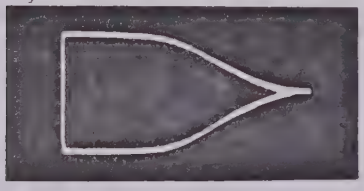


FIG. 22 NORMAL CHROMA SWEEP

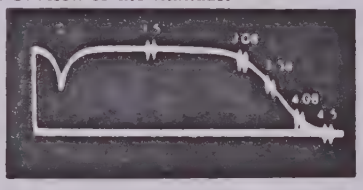


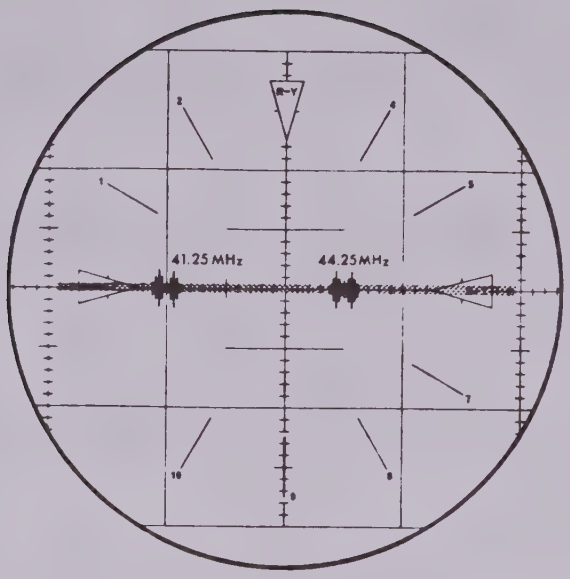
FIG. 23 WIDENED CHROMA SWEEP

Any peaks or valleys found in the waveform will be the result of a defective component in the video system. An open peaking coil may cause a drastic dip in the waveform showing a loss of gain and resulting in a poor picture on the screen of the CRT. When using the widened sweep on the chroma signal, the 45.75 marker becomes (0) zero and the 44.25 marker becomes 1.5 MHz with the other markers as marked on the front panel. With the linear sweep of the SM152, the scope screen can be divided up as described in "FINDING MARKER POINTS OTHER THAN THOSE PROVIDED". This sweep signal can also be used to check out the scope response to see just how flat your service scope is.

FINDING MARKER POINTS OTHER THAN THOSE PROVIDED

The Sencore SM152 has eight crystal controlled markers available to cover all the major points on the response curve. There are times however, that markers other than those provided may be desired for various reasons. The SM152 sweep is so linear that the different marker points can be approximated on the scope screen with ease. For most alignment work, this method is fast and easy. If greater accuracy is desired, the following method can be used to calibrate the horizontal trace for exact frequency points.

Connect the SM152 to the oscilloscope without any signal going into the detector input jack. Depress the 41.25 and 44.25 marker buttons and adjust the tuning so that the markers appear on the scope screen. Adjust the oscilloscope horizontal gain so that the trace is eight equal divisions long. Adjust the sweep width control, the tuning control, and the sweep direction switch until the 41.25 marker is on the line between the second and third divisions and the 44.25 marker is on the line between the fifth and sixth divisions. See figure 24. Now shift the position of the horizontal trace with the oscilloscope horizontal centering control one fourth of a division to the right. The lines on the scope screen are now exact even megahertz points of 39 through 47 MHz as shown in figure 25. Any frequency in this range may now be found by using the markings on the scope screen.



CALIBRATION OF SCOPE SCREEN

FIGURE 24

CALIBRATION OF SCOPE SCREEN IN EVEN MHz

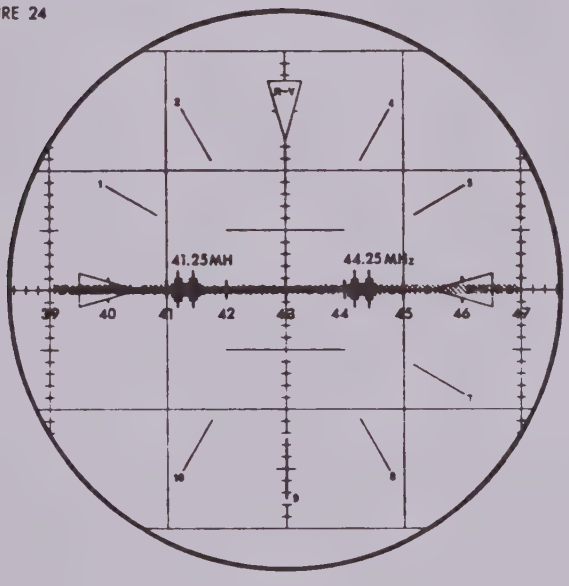


FIGURE 25

Using the above method other markers may be used to calibrate the scope screen for other frequency ranges.

Occasionally a 45 MHz marker is required in some alignment procedures. Although this marker is not directly available from the SM152 the 45 MHz point on a response curve can be easily and accurately determined, because it is exactly half way between the 44.25 and 45.75 markers which are available. It is not necessary to calibrate the horizontal sweep to determine the 45 MHz point, just judge where the half way point is located.

USING AN EXTERNAL MARKER GENERATOR

An external marker signal may be used with the SM152 to provide a marker point other than that found on the front panel. The signal from the marker generator is connected to the SM152 through the external marker jack on the front panel. To use this provision, couple a signal into the external marker jack and depress the external marker button on the right side of the front panel. The external marker frequency will now appear as a regular birdie marker on the response curve, when it is within the swept frequency range of the SM152. It it is not within this range, the tuning control will have to be tuned until the marker appears, or the marker generator adjusted until the marker appears on the scope screen. A variable marker generator or crystal oscillator may be used to provide the external marker signal. The input must be 25 millivolts or more with an impedance of 50 to 90 ohms to match the input of the SM152.

I.F. SPOT ALIGNMENT

Some manufacturers recommend that the IF transformers be preset before sweep alignment of the receiver is started. This also holds true of the traps in many cases because if a trap is off, it can affect the overall response curve of the set. To use the spot align band of the SM152 proceed as follows:

1. Connect the RF cable using the 39G22 matching pad to the mixer tube or test point as described in "CONNECTING THE SM152 FOR ALIGNMENT".

2. Set the Range switch of the SM152 to the IF SPOT BAND.

3. Connect a bias supply or short out the IF AGC test point as recommended by the manufacturer of the set.

4. Disable the tuner by placing it between channels or switching to the UHF position if no UHF tuner is used.

5. Connect a DC voltmeter to the video detector load resistor.

6. Set the TUNING dial to each of the trap frequencies and adjust the associated trap for a minimum reading on the meter.

7. Set the TUNING dial to each of the IF transformer frequencies listed and adjust the associated IF transformer for maximum reading on the meter.

This will preset all of the traps and IF transformers in the IF system, and very often will bring the IF response very close to the final result.

The IF RESPONSE CURVE CHECK outlined in a preceding section should now be made. The IF transformers can be touched up for the best response curve.

Note: It is a simple matter to check the accuracy of the IF SPOT band, and if it is off slightly can be easily put back on with the FREQUENCY CAL control on the rear

of the SM152. With a scope hooked up to the SM152 just push in all of the IF marker buttons and look for zero beats as you tune through each of the marker frequencies.

TUNER ALIGNMENT

The SM152 covers the entire VHF and UHF band of frequencies making it ideal to check out and align TV tuners. Two high band VHF and two low band VHF channel markers that are most often referred to in service literature, are provided on the SM152. To check out a VHF tuner for alignment, connect the SM152 as follows:

VHF TUNER ALIGNMENT

1. Connect the RF cable terminated with the 39G22 matching pad to the VHF antenna terminals of the tuner.

2. Apply 2 volts of bias, or the manufacturers recommended level, to the tuner AGC line. If the tuner is a tube type, the bias is negative; if solid state, a positive voltage is applied.

3. If the tuner has an RF test point, connect the red lead from the 39G23 detector probe to this point. Some tuners use the IF output jack, requiring a demodulator probe. Use the Blue lead from the 39G23 at this point.

4. Connect the scope vertical input lead to the SCOPE V jack on the SM152.

5. Set the SM152 Range switch to the 110 - 230 MHz range and the TUNING control to the center of channel 10 as marked on the dial. Set the TV tuner to channel 10.

6. Depress the CH10 marker button in the RF MARKER section and the 4.5 Marker button in the IF marker section. The curve should appear as shown in figure 26. The tuner response curve is also shown on the front panel. The fine tuning of the TV tuner may have to be adjusted slightly to bring the response curve and markers to the right point as shown.

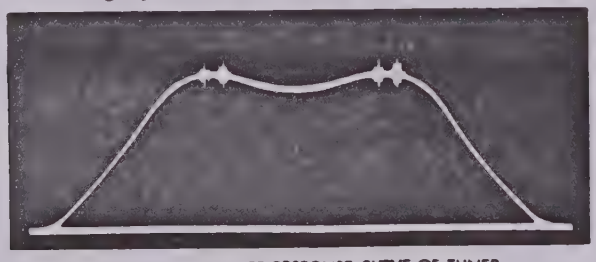


FIGURE 26 IDEAL RF RESPONSE CURVE OF TUNER

Note: Both the upper and lower side bands of the 4.5 MHz sound carrier are present in the marker system, and it is possible to mistune the TV to the lower sideband. To insure that you are tuned properly, tune the channel 10 marker to the center of the screen, and increase the frequency from the SM152 by turning the TUNING control clockwise. The channel 10 marker should move to the left. If not, reverse the sweep direction switch. The TV can then be properly tuned by placing the channel 10 marker on the left side of the response curve.

Channels 4, 5, and 13 may be checked in the same manner. If any channel requires adjustment, the converter grid trimmers or RF trimmers can be touched up to give the proper display on the scope screen. The SM152 can also be used to adjust the oscillator trimmers to put the fine tuning in the center of its range.

UHF TUNER CHECK

The UHF tuner is checked by applying a signal to the tuner and observing the output obtained at the detector.

1. Connect the RF cable terminated with the 39G22 matching pad to the UHF antenna terminals on the TV.

2. Connect the scope vertical input lead to the SCOPE V jack on the SM152.

3. Connect the red lead from the 39G23 detector probe to the output of the video detector.

4. Connect a bias to the IF AGC test point of approximately 2 to 3 volts negative for tube receivers. Solid State receivers generally require a positive voltage.

5. Set the SM152 RANGE switch to 440-920 MHz and tune to the low end of the band. Sweep width should be set at maximum until a response is obtained and then should be reduced until the response fills the screen.

6. Tune the TV UHF tuner to match the tuning of the SM152 until a response is seen on the scope. Gradually increase the frequency of both the SM152 and the TV until the entire UHF band has been covered, always keeping the response in view on the scope. Rapid changes in response amplitude at some parts of the band indicate a "suck out" in the tuner. Frequency or channel indication on the tuner should be close to the indication on the SM152.

7. The SM152 uses the calibrated fourth harmonic of the 110 - 230 MHz range for the UHF sweep. It will also be possible to obtain a response curve using the third harmonic of the 110 - 230 MHz band. This third harmonic will tune between 330 and 690 MHz which covers the lower portion of the UHF band. It is easy to distinguish between the third harmonic and the fourth harmonic because the third harmonic will be somewhat stronger than the fourth, and the third harmonic will not follow the calibrations on the dial. To be sure that you are using the fourth harmonic, tune the SM152 and the TV set to channel 14 and the response curve should appear on the scope. If you do not get the response curve, just rock the tuning of the SM152 and the TV set back and forth until the response curve appears. The response curve should appear within 6 channels of the calibrations on the TV tuner.

When the proper harmonic is tuned in for UHF, you will also note a rather large response curve from the UHF tuner under test at 720 MHz. This is due to the feed through of the UHF oscillator in the tuner and makes this section of the band questionable for alignment purposes. This will cover only two to three channels and will not affect the usefullness of the SM152 at UHF.

FM ALIGNMENT WITH THE SM152

Complete alignment of the RF and IF amplifiers in FM receivers can be performed with the SM152 sweep marker generator. The SM152 will provide the RF signal from 88 to 108 MHz when the range switch is set on the 50 to 120 megahertz band,

and will provide the 10.7 MHz swept signal for IF alignment on the 10 to 55 megahertz band. The 10.7 MHz marker has automatic 100 KHz side markers of 10.6 MHz and 10.8 MHz when the button is depressed. A nonswept 10.7 MHz crystal controlled signal is also available from the 10.7 MHz jack on the front panel. Alignment of the FM stereo receiver should be performed with the sweep signal. If the receiver is a monophonic type, the 10.7 crystal signal from the jack may be used.

SWEEP ALIGNMENT OF THE IF:

Sweep alignment of the FM receiver IF is best as the bandwidth can be seen and made wide enough to get all of the FM signal through. This is especially important in stereo as the bandwidth of the signal is wider than the normal monophonic FM signal and requires a wider bandwidth in the IF amplifier. To Sweep align the FM receiver, follow these simple steps:

1. Connect the RF cable from the SM152 terminated with the 39G22 matching pad to the FM receiver by capacity coupling into the mixer tube or into the mixer test point as indicated by the manufacturer. In solid state, this is generally the base of the mixer transistor or the gate, if an FET is used.

2. Set the Range switch on the SM152 to the 10 - 55 MHz range and tune to the 10.7 spot marked on the dial.

3. Set the sweep width to about .5 megahertz.

4. Tune the FM receiver to around 108 MHz or some quiet spot in the band.

5. Connect the Red lead of the 39G23 detector probe to one side of the ratio detector, or to the center tap of the last transformer in a discriminator circuit.

6. Connect the scope vertical input to the SCOPE V jack on the front panel.

7. Adjust the RF coarse and fine controls on the SM152 for a response curve on the scope. Depress the 10.7 MHz FM IF marker button. The markers should fall as shown in figure 27 if the IF is in proper alignment. The IF transformer slugs should be adjusted for a peak at 10.7 with the 100 KHz limit markers at equal amplitude as shown.

8. Remove the Red lead of the 39G23 detector probe and connect it to the audio output of the detector circuit. The "S" curve as shown in figure 28 should now appear on the scope screen. Adjust the secondary of the transformer to make the 10.7 MHz marker fall on the base line of the curve and the 10.6 and 10.8 MHz markers equal distance from the base line for best symmetry.

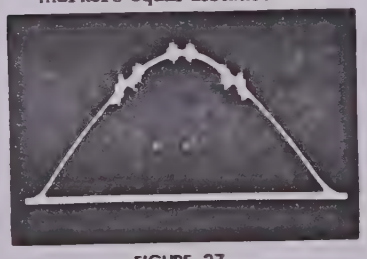


FIGURE 27
FM IF RESPONSE CURVE

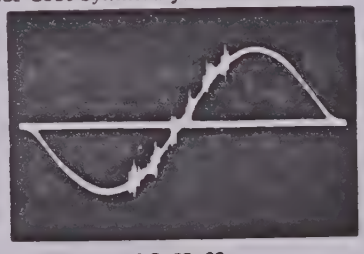


FIGURE 28
"S" CURVE FROM FM DETECTOR

PEAKING THE FM IF WITH THE 10.7 MHz CRYSTAL SIGNAL

On monophonic receivers, the IF transformers can simply be peaked for maximum gain at 10.7 MHz, using the signal from the 10.7 MHz out jack on the front panel of the SM152.

1. Plug a lead into the 10.7 MHz Out jack and connect a 220 pf capacitor to the red lead. Connect this to the mixer tube shield or to the mixer test point as indicated by the manufacturer. The black lead is connected to the chassis ground or common point as close to the mixer injection point as possible.

2. Connect a high impedance meter such as the Sencore FE14 to the center tap of the discriminator transformer or to one side of the ratio detector. Adjust the IF transformer slugs for maximum reading on the meter.

3. Remove the meter from the detector and connect the lead to the audio output point of the detector. Here a zero center scale meter will be best. Adjust the detector transformer for a zero reading on the meter. The reading will be positive on one side of the zero point and negative on the other. The point that gives no voltage or a zero reading is the correct point.

MAINTENANCE

DISASSEMBLY INSTRUCTIONS

For calibration of the various RF bands and other internal adjustments, the SM152 must be removed from its case. To remove the SM152 from the case, follow these steps:

1. Set the SM152 face down on the bench and remove the three screws holding the bottom of the front panel to the case.

2. Remove the two screws holding the back of the case to the chassis.

3. Slowly lift the case away from the chassis and panel. This will expose the internal parts for adjustment and maintenance.

After the case has been removed, the different boards and assemblies can be taken apart for service if necessary. Each board or section is listed below separately.

CONTROL BOARD

To remove the control board for service, simply remove the four screws, one at each corner of the board. Be careful of the lower left hand corner as the screw also mounts the heat sink of a transistor. When remounting the board, be sure that the transistor is remounted in the same manner.

TUNER

The tuner is easily removed from the main chassis by simply removing the two screws, one at each end of the tuner. This will expose the amplifier board and the two oscillator boards.

The Amplifier board may be removed for service as follows:

1. Remove the seven connectors on the top of the tuner.

2. Remove the four screws holding the board from the top of the tuner.

3. Unsolder the filter lead at the one corner of the board and the board is now free from the tuner.

If only the dual gate MOSFET is to be replaced, the amplifier board does not have to be removed from the tuner. The MOSFET is mounted in a socket and can be removed by opening the tuner and exposing the circuit boards.

The two oscillator boards are eyelet boards and do not actually need to be removed for service as all of the connections can be reached from the top of the board. The eyelet boards are mounted by a single nut holding a feed-through capacitor and two tack soldered connections. When removing the boards, it will be necessary to remove the pickup loop.

ALC BOARD

The Automatic Level Control board is mounted on the attenuator switch and most points can be reached for service without removing the board. If you wish to remove the board, it is held by two screws to the bracket on the attenuator switch. The heavy wire coming from the rear of the attenuator switch to the bottom of the ALC board will have to be unsoldered at the board.

MARKER BOARD AND DIAL STRINGING

The marker board can be removed for servicing, and must be removed if it should be necessary to restring the band switch or tuning assemblies. The first two steps following are all that are necessary for marker board removal. All four steps are necessary if a dial cord is to be replaced.

1. Remove the three screws holding the push buttons to the front panel.

2. Remove the two screws holding the marker board to the main chassis.

3. Remove the four screws holding the main chassis to the mechanical chassis. Two are located near the control board and the other two near the tuner.

4. The main chassis is pulled back and pulled away from the marker board. This will expose the marker board and the dial mechanism for servicing.

PILOT LAMP REPLACEMENT

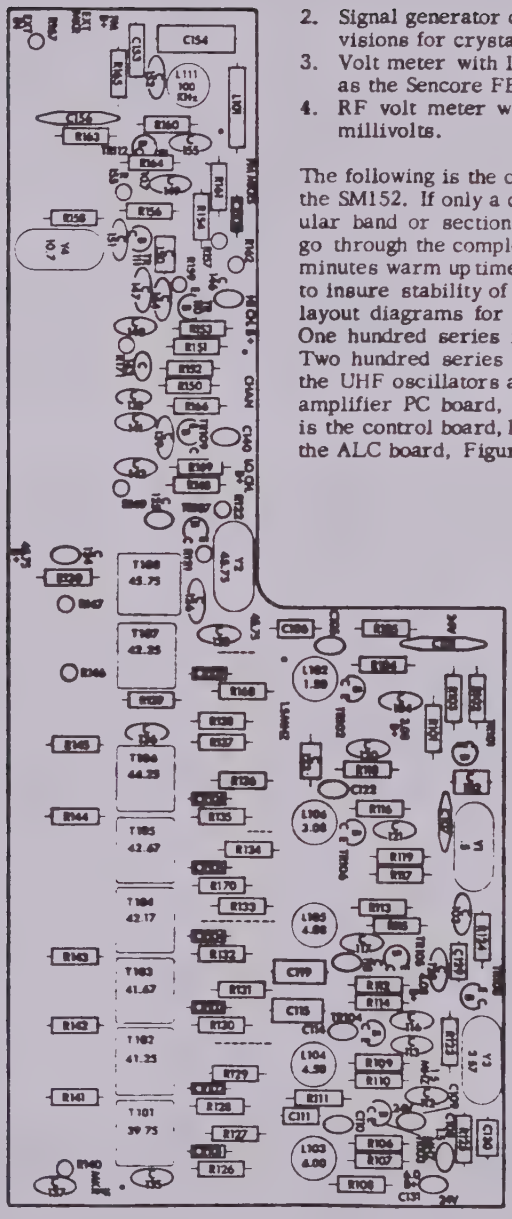
To replace the pilot lamps illuminating the dial of the SM152, remove the unit from its case.

1. Set the RANGE switch to the IF SPOT BAND position. This will expose the metal plate on the dial drum.
2. Remove the two screws holding this plate to the drum and lift away from the drum. This will expose the two pilot lamps in their holders. Replace with number 51 bulbs.

ALIGNMENT INSTRUCTIONS FOR THE SM152

Equipment Needed:

1. Oscilloscope such as the Sencore PS148 or equivalent.



2. Signal generator covering 10 to 240 MHz with provisions for crystal check points.
3. Volt meter with 15 megohm input impedance such as the Sencore FE14, FE16, FE149 or equivalent.
4. RF volt meter with a minimum sensitivity of 10 millivolts.

The following is the complete alignment procedure for the SM152. If only a check or realignment of a particular band or section is required, there is no need to go through the complete procedure. Allow at least 10 minutes warm up time before realignment of the SM152 to insure stability of all circuits. Use printed circuit layout diagrams for location of the various controls. One hundred series is the marker board, Figure 29; Two hundred series is the tuner shown in two parts, the UHF oscillators and filter, Figure 30; and the RF amplifier PC board, Figure 31; Three hundred series is the control board, Figure 33;Four hundred series is the ALC board, Figure 32.

FIGURE 29
MARKER P.C. BOARD LAYOUT

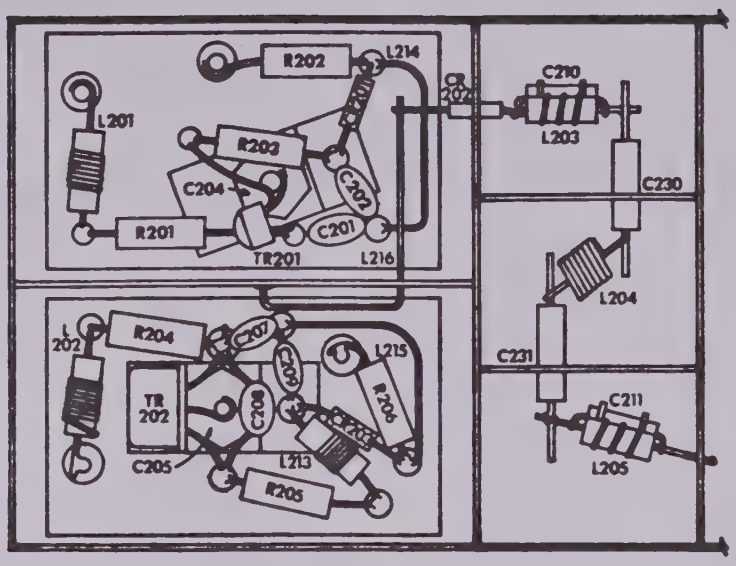


FIGURE 30
UHF OSCILLATORS AND FILTER LAYOUT

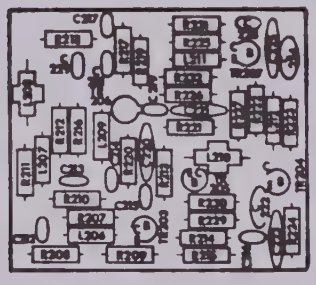


FIGURE 31
R.F. AMPLIFIER P.C. BOARD LAYOUT

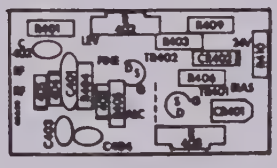


FIGURE 32
ALC P.C. BOARD LAYOUT

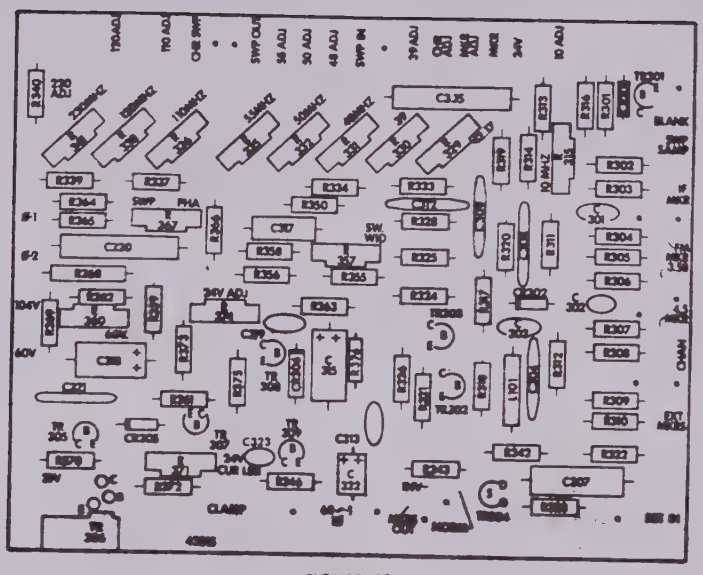


FIGURE 33
CONTROL P.C. BOARD LAYOUT

INTERNAL ADJUSTMENTS

POWER SUPPLY

1. Set the current limiting control R371 on the control board fully clockwise.
2. Connect a 15 megohm meter to the 24 volt line. You can use the positive end of C315 or the 24 V eyelet on the board.
3. Adjust the 24 V ADJ, R374 on the control board till the meter reads 24 volts.
4. Connect the meter to the 60 volt line. You can use one end of C321 or connect to the eyelet marked 60 V on the board.
5. Adjust the 60 V ADJ, R360 on the control board until the meter reads 60 volts.
6. Repeat steps 2 through 5 a second time as some slight interaction is common.
7. Connect the meter to the 24 volt line and place a 1000 ohm 2 watt resistor from the 24 volt point to ground.
8. Adjust the CUR. LIM. control R371 on the control board until the 24 volt line drops to 23 volts. This sets up the current limiting circuit.

For the following alignment of the RF bands, these preliminary steps are required. Once this set up is made, no further adjustment of the controls listed will be made unless specifically noted in the procedure.

1. Connect the vertical input of the oscilloscope to the SCOPE V jack on the front panel of the SM152. Set the horizontal selector switch of the scope to LINE. If the scope has no line position, use the SCOPE H signal from the SM152 for the horizontal input to the scope.

2. Set the SWEEP WIDTH and MARKER HEIGHT controls to maximum and the MARKER WIDTH switch to WIDE.

Note: In calibrating the ends of the RF bands you will be observing a marker on the oscilloscope and centering it on the trace. To get the most accurate adjustment, reduce the SWEEP WIDTH after a marker is obtained. This expands the center of the trace, permitting precise centering of the marker.

3. Insert the output of an external signal generator into the EXT MKR jack on the front panel and depress the EXT MKR button.

4. Set the FREQ CAL control located on the rear of the SM152 to the physical center of its range.

10 to 55 MHz Band Adjustment

1. Set the RANGE switch to the 10 to 55 MHz band and the TUNING control until the pointer rests directly on 10 on the dial.

2. Set the external generator to 10MHz. A marker should now appear on the scope screen on the baseline. Adjust the 10 MHz adjust, R315 until this marker is centered on the scope screen. If no marker is visible, rotate the 10 MHz adjust until the marker is seen on the scope screen and then center marker.

3. Set the TUNING control until the pointer rests on 55 and the external generator to 55 MHz.

4. Center the marker seen on the scope with the 55 MHz adjust R335.

This sets up the 10 to 55 MHz band. There is no interaction between the 10 and 55 MHz adjustments, but the 10 MHz adjustment can affect all other RF bands.

It is a good idea to recheck the 10 MHz adjustment periodically during the alignment for any possible drift. A good fast check is to use the 10.7 MHz crystal in the SM152.

Simply set the TUNING control until the pointer rests on the 10.7 red mark on the dial and depress the 10.7 MHz marker button. Three markers will appear on the scope screen with the 10.7 being the larger center marker. This marker should fall in the center of the scope screen if the 10 MHz adjustment has not drifted. If the adjustment is off, the 10.7 MHz crystal can be used to put it back on by simply centering the marker as before with the dial set to 10.7.

50 to 120 MHz Band Adjustment

1. Set the RANGE switch to the 50 to 120 MHz band and the TUNING control until the pointer rests on the 50 on the dial.
2. Set the external generator to 50 MHz.
3. Center the resultant marker on the scope screen with the 50 MHz ADJ, R332.
4. Set the external generator to 120 MHz and adjust the TUNING control so the pointer rests on 120 on the dial. Center the resultant marker on the scope screen with the 120 MHz ADJ, R338.
5. Repeat steps 1 through 4 two or three times for best accuracy, as the two controls will interact.

110 to 230 MHz Band Adjustment

1. Set the RANGE switch to the 110 to 230 MHz band and adjust the TUNING control so the pointer rests on 110 on the dial.

2. Set the external generator to 110 MHz.
3. Center the resultant marker on the scope screen with the 110 MHZ ADJ, R336.
4. Set the external generator to 230 MHz and adjust the TUNING on the SM152 so the pointer rests on 230 on the dial. Center the resultant marker with the 230 MHz adjust R341.
5. Repeat steps 1 through 4 two to three times as the controls will interact.

IF Spot Align Band, 39 to 48 MHz Adjustment

1. Set the RANGE switch to the IF SPOT ALIGN band and adjust the TUNING control so the pointer rests on 39 on the dial.
2. Set the external generator to 39 MHz.
3. Adjust the 39 MHz ADJ, R330 for the proper null. The null will be noted as a dip between two large beats. You will note this as you slowly rotate R330 from one end to the other. First a large beat will occur and then drop off sharply to a grassy horizontal trace. Then as you continue to turn the adjustment, the beat will increase sharply again. The point between the two beats as noted on the scope is the correct setting of the adjustment.
4. Set the external generator to 48 MHz and adjust the TUNING control so the pointer rests on 48 on the dial.
5. Adjust the 48 MHz ADJ, R331 until the proper null is centered as previously described.
6. Repeat steps 1 through 5 two or three times as the controls will interact with each other.

10 and 100 Millivolt RF output level

1. Set the RANGE switch to the 110 to 230 MHz band and adjust the TUNING control so the pointer rests on 130 MHz on the dial.
2. Set the RF OUTPUT COARSE and RF FINE controls to maximum.
3. Connect an RF voltmeter to the output of the SM152 using the 75 ohm output cable. Do not use the 300 ohm matching pad. The RF voltmeter should have 75 ohms input.
4. Adjust the RF output (with the BLANKING switch on the rear of the SM152 held to remove the blanking) for a reading of 100 millivolts using R408 located on the ALC board on the attenuator switch.
5. Turn the RF FINE control fully counter clockwise to minimum and adjust R402 on the ALC board for a reading of 10 millivolts while holding the BLANKING switch to remove the blanking.

Marker Adjustment

For marker alignment, the connection from the front panel of the SM152 so the scope can now be removed. Both the vertical and horizontal inputs of the scope will be used to form Lissajous patterns.

1. Connect the Horizontal input of the scope to the collector of TR101, the 0.5 MHz crystal oscillator. The horizontal input will be left here for the adjustments of the 1.5, 4.5, and 6 MHz coils.
2. Connect the vertical input of the scope to the center tap of the 1.5 MHz coil on the marker board. The center tap can be located by the twisted wires going to it and for all three coils faces toward the front panel.
3. With the scope attached as above, adjust the 1.5 MHz coil until you have three loops or peaks on the Lissajous pattern as shown in figure 34A.
4. Next connect the scope vertical input to the center tap of the 4.5 MHz coil and adjust the coil for 9 peaks as shown in figure 34B. Be sure that you have the nine

peaks as the coil will tune to eight and ten which will be the wrong frequency.

5. Next connect the scope vertical input to the center tab of the 6 MHz coil and adjust for 12 peaks as shown in figure 34C.

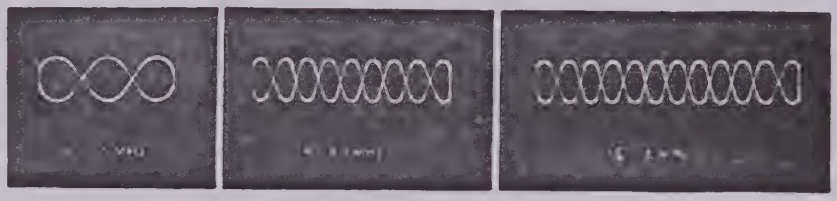


FIGURE 34

For setting the 3.08 and 4.08 MHz markers, the horizontal input lead will be removed and the scope set to the 500 KHz sweep range.

1. With the scope set to the 500 KHz sweep range, put the vertical input probe on the collector of the 3.58 MHz oscillator, TR108. This is the junction of R123 and R125 near the crystal. Set the FINE sweep control on the scope until seven cycles are displayed on the scope screen and locked in.
2. Connect the scope vertical input lead to the center tab of the 3.08 MHz coil and adjust the coil until six cycles are locked in on the screen. It is not necessary to be extremely accurate at this time as the coils will be peaked again later for a more precise setting.
3. Connect the vertical input of the scope to the center tab of the 4.08 MHz coil and adjust the slug for eight cycles on the screen. This coil will also be peaked later along with the 3.08 for more precise settings.

Now the scope will be connected back to the SCOPE V jack and the horizontal selector switch set to line position as in normal sweep alignment set up. Set the RANGE switch to the 10-55 MHz band and the TUNING dial to 43 MHz. The SWEEP WIDTH control, MARKER WIDTH control and MARKER HEIGHT control are set to maximum.

1. Depress the 45.75 MHz marker button on the front panel and adjust transformer T108 for maximum height of the marker on the scope screen.
2. Depress the 42.17 MHz marker button. The marker may or may not appear on the scope screen. Adjust T104 until the marker appears and peaks at maximum.
3. Depress the 3.08 and 4.08 marker buttons. Peak T103 for maximum 4.08 marker on the scope screen. You can also go back at this time and peak L105 in the 4.08 oscillator circuit for maximum. Adjust T105 and L106 in the 3.08 oscillator for maximum 3.08 marker. These markers should be equal distance from the 3.58 marker on the screen. Expand and recenter the trace by reducing the sweep width and adjusting the TUNING control to center the 3.58 marker on the screen. You can now measure the distance between the 4.08 and 3.08 markers to the 3.58 marker.
4. Release the 3.08, 3.58 and 4.08 marker buttons and depress the 47.25 and 44.25 marker buttons. Adjust T107 for maximum 47.25 marker on the screen. Repeak L102, the 1.5 MHz coil for maximum at this time also, while observing the 47.25 marker. Adjust T106 for maximum 44.25 marker on the scope screen. The 44.25 and 47.25 markers should be equal distance from the 45.75 marker on the scope screen. This may be checked by expanding and recentering the sweep as described when checking the 3.08 and 4.08 markers.
5. Release the 47.25 marker button and depress the 41.25 marker button. Adjust transformer T102 for maximum 41.25 marker on the scope screen. The distance between the 41.25 and 44.25 markers is 3 MHz, and between the 44.25 and 45.75

is 1.5 MHz. To check the 41.25 marker, it should be twice as far from the 44.25 marker as the 45.75 marker.

6. Depress the 39.75 marker button and adjust T101 for maximum marker height. Repeak L103, the 6 MHz coil at this time for maximum height of the 39.75 marker. The distance between the 39.75 and 41.25 marker will be the same as the distance between the 44.25 and 45.75 markers.

Alignment of the RF markers will require feeding a signal from an external generator into the EXT MKR jack on the front panel of the SM152.

1. Set the RANGE switch to the 50 to 120 MHz band and the TUNING control to channel 4 on the dial.
2. Set the external signal generator to 67.25 MHz and depress the EXT MKR Button. With the TUNING control, center this marker on the scope screen.
3. Depress the Channel 4 marker button and adjust L107 until the marker coincides with the external marker. L107 is mounted on the channel 4 push button switch.
4. Set the external signal generator to 77.25 MHz and the TUNING on the SM152 to channel 5 and center the resultant marker.
5. Depress the channel 5 marker button and adjust L108 until the marker coincides with the external marker.
6. Set the external generator to 193.25 MHz and the RANGE switch on the SM152 to the 110 to 230 MHz band. The TUNING control should be set to channel 10, and the external marker centered on the scope screen.
7. Depress the channel 10 marker button and adjust L109 until the marker coincides with the external marker.
8. Set the external generator to 211.25 MHz and the TUNING control on channel 13 to center the external marker.
9. Depress the channel 13 marker button and adjust L110 until the marker coincides with the external marker on the scope screen.

Sweep Width Adjustment

The internal sweep width adjustment can now be set up using the crystal markers generated by the SM152 marker section.

1. Connect the scope vertical input and horizontal input to the respective jacks on the front panel of the SM152.
2. Set the RANGE switch to the 10 to 55 MHz band, the TUNING control to about 44 MHz and the SWEEP WIDTH to maximum.
3. Depress the 47.25 MHz marker button and center the marker on the scope screen with the TUNING control. Flip the SWEEP DIRECTION switch back and forth to be sure that you have the marker centered. If the marker does not move when the switch is flipped back and forth, the marker is centered.
4. With the 47.25 MHz marker centered, depress the 39.75 marker button. This marker is 7.5 MHz away from the 47.25 MHz marker and should fall at the end of the scope trace. Adjust the internal sweep width control R357 until this marker falls at the end of the trace. Flip the sweep direction switch to be sure that the marker will appear at the opposite end of the trace when the sweep direction is reversed.

Sweep Phase Adjustment

There are two adjustments for sweep phase on the SM152, one for compensation of the horizontal of the scope used and the other to compensate and adjust the phase between the blanking and the sweep signal. The external phase control is adjusted first and then the internal phase is adjusted.

1. Connect the vertical input of the scope to the blanking signal. This can be picked up at the junction of L2 and a shielded wire on the tuner terminal strip.
2. Connect the horizontal input of the scope to the SCOPE H jack and set the scope selector switch to External.
3. The display on the scope screen will be a rectangle. The corners should be square with no overshoot. If the corners are not square or there is overshoot on the edges, adjust the external Phase Adj on the rear panel of the SM152 until the corners are square and no overshoot is present.
4. Connect the vertical input of the scope to the SCOPE V jack on the front panel and leave the horizontal connected to the SCOPE H jack.
5. Set the SM152 to the 10 to 55 MHz range and set the TUNING to about 44 MHz.
6. Depress the 45.75 and 42.17 markers and adjust the TUNING until the markers are centered on the scope screen. Set SWEEP WIDTH at maximum.
7. Depress the BLANKING switch to remove the blanking and see if the trace and retrace markers coincide exactly on the screen as they should. If not, adjust the internal phase adjust R367 on the control board until they do.

DIAL STRINGING INSTRUCTIONS

The dial stringing on the SM152 is simple and easy to do if ever necessary. The system is composed of three separated closed loops, the Dial loop, the TUNING loop and the RANGE switch loop. Each of these is discussed separately below.

The Dial Loop

The dial loop is formed from a 37 inch (1/2 inch allowed for tying of knot) piece of .025 diameter non-stretchable dial cord. It is not necessary to actually measure the cord, because the loop can be made the correct length by merely following the stringing procedure outlined below. See Figure 35.

1. Wrap the cord around the large pulley next to the front panel on the TUNING control shaft three (3) times.
2. Thread the cord around the pulley to the left and then across the dial pointer opening in the front panel to the opposite pulley.
3. Pass the cord around the pulley mounted on the flat spring. While maintaining a tension on the cord, tie the two ends together so that the tension pulls the pulley on the spring up about 1/4 of an inch from the bottom of the mechanical chassis it is mounted on.

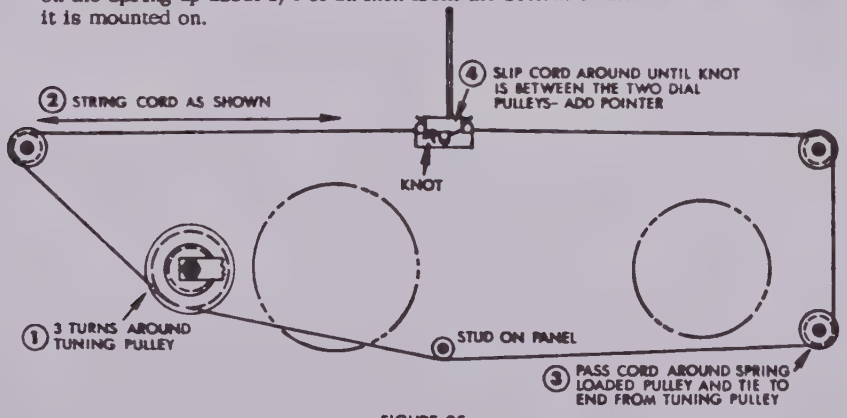

(4) SLIP CORD AROUND UNTIL KNOT IS BETWEEN THE TWO DIAL PULLEYS- ADD POINTER
(2) STRING CORD AS SHOWN
KNOT
(1) 3 TURNS AROUND TUNING PULLEY
STUD ON PANEL
(3) PASS CORD AROUND SPRING LOADED PULLEY AND TIE TO END FROM TUNING PULLEY

FIGURE 35
STRINGING THE DIAL POINTER CORD

4. Slip the string around the system until the knot is in the area of the pointer and place the knot directly behind the pointer so that it is locked between two tabs on the pointer.

With the TUNING control fully counter clockwise, the pointer should rest about 1/4 of an inch from the end of the dial markings. When the TUNING control is rotated to its extremes, the pointer should pass each end of the dial markings equally and if not, the string should be slipped around the large pulley until it does.

When the Dial pointer string is replaced, the position of the TUNING potentiometer should be checked as described under restringing of the TUNING control.

The Tuning Control Loop

The tuning control loop which drives the tuning control is "locked" to both the tuning shaft pulley and the control shaft pulley to prevent slipping when the dial end stop is encountered.

The cord installed at the factory is a loop approximately 23 3/4 inches in circumference. However, for field replacement it will be easier to thread the cord as required and not tie it into a loop first.

1. While observing the rear of the tuning assembly, loosen the set screw on the tuning control pulley and turn the control full CCW. Position the dial pointer, the tuning shaft arm and the stop plate on the control pulley as shown in Figure 35. The pointer is on the left side (when viewed from the rear) and the tuning shaft arm is parallel with the Chassis and engages the stop plate. Tighten the set screw.
2. Tie a small loop in the end of the replacement dial cord, hook it over the control pulley tab under the stop plate and string it CCW around the large pulley.
3. Wrap a full 3 3/4 turns around the front part of the tuning shaft pulley. Bring it up through the slot separating the front and rear pulleys, being sure that tension on the cord is maintained and that the shaft arm engages the stop plate.
4. Continue CCW 3/4 turn on the rear pulley.
5. Then bring the cord all the way around the control pulley into the opening and tie it on to the opposite tab from which you started. Wrap it around the tab twice before tying to prevent it from loosening.
6. Hook the spring over the beginning part of the cord onto the tab opposite.

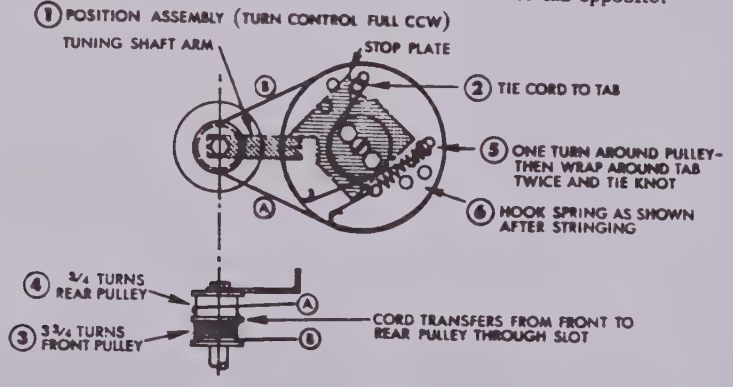

1 POSITION ASSEMBLY (TURN CONTROL FULL CCW)
TUNING SHAFT ARM
STOP PLATE
2 TIE CORD TO TAB
5 ONE TURN AROUND PULLEY- THEN WRAP AROUND TAB TWICE AND TIE KNOT
6 HOOK SPRING AS SHOWN AFTER STRINGING
4 3/4 TURNS REAR PULLEY
3 3 3/4 TURNS FRONT PULLEY
CORD TRANSFERS FROM FRONT TO REAR PULLEY THROUGH SLOT
A
B

FIGURE 36
STRINGING THE TUNING CONTROL CORD

Now that the TUNING control is strung, the potentiometer must be set so that there will not be any dead spots within the actual tuning range of the dial. With the SM152 off and not plugged into the line, follow these steps:

1. Connect an ohm meter from the center tab (blue lead) of the tuning pot to the white wire, and set the TUNING control until the pointer rests directly over the first mark on the left hand side of the dial (viewed from the front) and measure the resistance.
2. Connect the lead from the ohm meter connected to the white wire to the green wire of the TUNING pot and adjust the TUNING control until the pointer now rests on the last mark on the right hand side of the dial and measure that resistance.
3. Loosen the set screw in the large pulley and adjust the pot from the small hole in the bracket on the pulley until the resistances at the two extremes of the tuning dial are about equal.

The Range Switch Loop

The Range Switch loop controls the turning of the drum so that the proper scale is visible in the window when the RANGE switch is rotated.

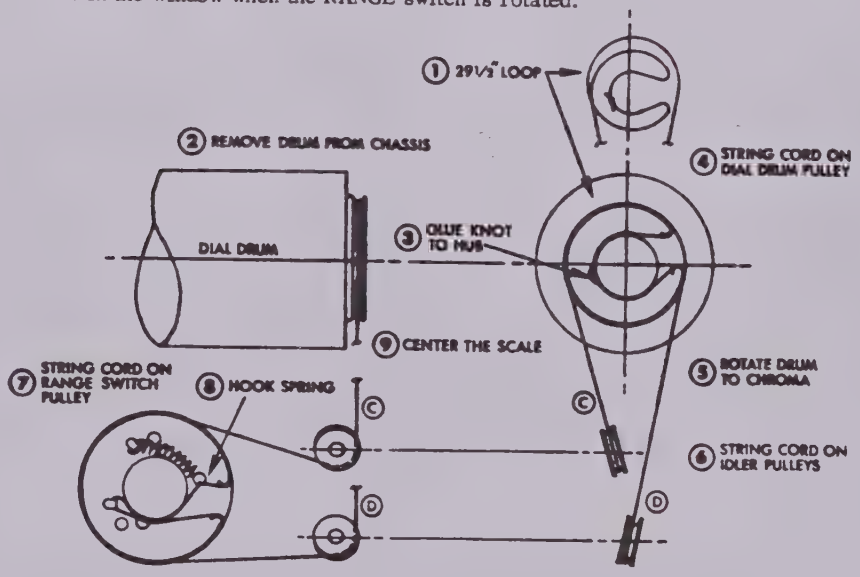


FIGURE 37
STRINGING THE RANGE SWITCH CORD

1. Prepare a dial cord into a loop with 29 1/2 inches circumference. When measuring the cord before tying allow a little extra for the knot (approximately one half inch). Try to be very exact on the size of the loop.
2. Remove the screw holding the tuning drum to the mechanical chassis and pull the drum out to expose the pulley end.
3. Glue the knot of the prepared dial cord loop to the center hub of the pulley, opposite the set screw. Wait for the glue to dry before proceeding.
4. The cord goes around the pulley hub and through the opening in the pulley. The knot glued to the hub will keep it from slipping. Wrap the two sides of the loop

3/4 of a turn around the pulley in opposite directions. Remount the drum being careful not to dislodge the cord from the pulley.

5. Carefully rotate the drum so that the CHROMA band shows in the front. Set the RANGE switch to the CHROMA band.
6. The cord coming from the side of the dial drum pulley closest to the front panel goes over the lower idler pulley to the bottom side of the RANGE switch pulley. The cord coming from the side of the dial drum pulley furthest from the panel goes over the upper idler pulley to the top side of the RANGE switch pulley.
7. Wrap each side of the cord around the RANGE switch pulley 3/4 of a turn in opposite directions and bring the remaining small part of the loop in through the opening on the side of the pulley and hook it over one of the tabs.
8. To tighten the loop hook the spring from one of the cords going to the pulley tab onto the tab opposite.
9. Set the RANGE switch to the 110 - 230 MHz band. If the scale is not centered in the panel window loosen the set screw on the dial drum pulley, center the scale and retighten the set screw.

CIRCUIT DESCRIPTION

The Sencore SM152 Sweep and Marker generator is a real breakthrough in sweep alignment equipment. Ultra linear sweep, flat RF output, crystal controlled markers and true post injection of the markers, all in one compact package. Let's see how this can be accomplished. Refer to the block diagram in figure 38 and the Schematic sheet during the following explanation.

The "Heart" of the SM152 is the tuner. The fundamental RF frequency output of 10 to 230 MHz is created by the difference frequencies of two UHF oscillators. Both oscillators are DC controlled with varicap diodes. The sweep oscillator operates at a center frequency of approximately 750 MHz and can be swept a maximum of 7.5 MHz above and below the center frequency at a 60 Hz rate. The Tuned oscillator is varied between 520 and 740 MHz with the TUNING control and the band edge adjustments on the control board. The tuned oscillator is blanked at a 60 Hertz rate so that sweep information will not appear on the scope screen during retrace. A 60 Hz sine wave converted to a square wave in the blanking amplifier TR301 is applied to the base of the tuned oscillator TR202 to prevent oscillations during the negative half cycle. The 60 Hz sine wave used to sweep the fixed oscillator must lag that used to form the blanking signal by 90 degrees, so that the sweep oscillator changes from its lowest frequency to its highest during the time the blanking oscillator is turned on. The 90 degree phase shift of the sweep signal is accomplished by the phase shift network and the internal phase adjust R367.

The difference frequency for the swept and tuned UHF oscillators is passed through a three section low pass filter to greatly reduce the UHF frequencies passed into the RF amplifier stage. The difference frequency is also fed into the sweep buffer emitter follower stage to be used for generating markers.

The RF amplifier, TR206 is a dual gate MOSFET. The difference signal from the filter is applied to the first gate, and an automatic level signal is applied to the second gate to control the gain of the transistor so that the output is flat with no peaks or valleys.

An emitter follower, TR207 matches the impedance of the RF amplifier to the attenuator. The output of the emitter follower feeds both the attenuator switch and the Automatic Level Control (ALC) circuit.

The ALC circuit samples the RF output of the emitter follower with a diode doubler

circuit. The resultant DC voltage is used to control the conduction of an FET. The drain of the FET is tied to the second gate of the RF amplifier so that the drain voltage becomes the controlling bias for the RF amplifier. If the RF output changes, the bias from the detector changes, changing the drain voltage of the FET and the gain of the RF amplifier. A second FET connected for constant current operation increases the gain of the ALC amplifier and also provides temperature compensation. The RF FINE-CHROMA control on the front panel controls the conduction of the FET and acts as a fine attenuator, controlling the RF output of the RF amplifier from between 10 and 100 millivolts.

The Chroma signal is generated by presetting the sweep width and tuned oscillator frequency to produce a 42.17 signal swept at 3 MHz, and adding a 45.75 crystal controlled video carrier signal. The Chroma signal is fed to the attenuator and to the chroma amplifier consisting of TR204 and TR205. The Chroma amplifier mixes and amplifies the difference frequency producing a 3.58 MHz swept signal for direct use into TV bandpass amplifiers. The output is taken from TR205, an emitter follower to prevent loading of the amplifier. Since the signal originates in the RF amplifier, output level is controlled with the RF FINE-CHROMA control.

The RF signal from the SM152 is coupled through the attenuator switch to the RF output jack. The switch has four 20 db steps of attenuation. Thus, the RF output signal can be controlled over a total range of 10 to 100,000 microvolts with the OUTPUT and RF FINE controls. This signal is coupled into the matching pad, 39G22 which matches the 75 ohm output of the generator to the 300 ohm input of the TV and FM receivers.

After the RF signal has gone through the various amplifiers in the reveiver under alignment, the response curve is taken from the receiver with the 39G23 detector probe and coupled into the response amplifier. When the signal comes from the video detector, it is coupled through an isolation resistor to the response amplifier using the red lead of the 39G23 probe. When the signal must be detected, as in the case of the chroma bandpass amplifier, the blue lead couples the signal into a video detector built into the 39G23 probe. The detected signal is again coupled into the response amplifier.

The response amplifier, TR304 is a junction FET phase spliting amplifier that provides response curves of normal and inverted polarities. The desired polarity for viewing on the scope is selected by the front panel RESPONSE PATTERN switch. The signal is then fed to the SCOPE V jack to be coupled into the vertical amplifier of the scope.

A baseline clamp, TR309 is used to prevent the baseline from shifting when using a DC scope for sweep alignment. It is controlled by the blanking signal so that when the tuned oscillator is turned off and no signal is present, TR309 conducts heavily and keeps the scope base line from shifting during retrace.

The marker generator for IF and Chroma markers uses signals from three crystals, 45.75 for the video carrier, 3.58 MHz for the color subcarrier and 0.5 MHz. The 0.5 MHz crystal signal is multiplied to form 1.5, 4.5, and 6 MHz signals. These in turn are used to generate the sound carrier and the trap marker frequencies. The 0.5 MHz signal is also beat against the 3.58 MHz signal to form the 3.08 and 4.08 MHz color sideband limits. The resultant signals are then mixed with the 45.75 video carrier crystal signal and the outputs are developed across tuned transformers to form the IF markers. When the front panel push button is depressed, the appropriate signal is picked up and coupled to the birdie amplifier. The 3.58 and the 4.5 sound subcarrier markers are picked up direct when these buttons are depressed.

The four RF channel markers are formed by extremely stable free running oscillators. Low band Markers for Channels 4 and 5 are generated in one oscillator stage by changing coils. High band markers for Channels 10 and 13 are generated in a second oscillator stage. Only one RF marker is available at a time as interlocking push buttons are used. The RF frequency is coupled to the birdie amplifier when the button is depressed.

The 10.7 MHz FM marker is composed of a 10.7 MHz crystal signal and a free running 100 KHz oscillator to produce 10.6, 10.7, and 10.8 MHz markers. When the 10.7 MHz marker button is depressed, the 10.7 MHz marker and the two limit markers are coupled to the birdie amplifier. The 10.7 MHz crystal signal is also made available at the front panel when the button is depressed.

An external marker may also be injected into the front panel jack and when the EXT MKR button is depressed, the frequency inserted is coupled to the birdie amplifier.

At the input of the birdie amplifier, TR302, the sweep sample from the sweep buffer stage in the tuner and the marker signals are mixed together. When the swept RF passes through the marker frequency, a beat is created. This beat is amplified in the birdie amplifiers TR302 and TR303. The amplified zero beat, or birdie, is coupled to the SCOPE V jack through a frequency selective network to control the frequency passed to limit the size of the marker. In the NAR or narrow position, the frequency is extremely limited so that the size of the marker is small while in the wide position, a greater frequency is passed and therefore a larger or wider marker is seen on the scope screen.

The power supply consists of two regulated supplies of 24 and 60 volts DC. Each has its own secondary on the power transformer and the unregulated DC is derived from a half wave rectifier and filter. The 24 volt supply uses a series regulator and an error amplifier reference transistor with a zener diode CR306 providing the DC reference. The base of the reference and error amplifier transistor is set up with the internal 24 volt adjust R374 to give 24 volts output. If the current drain from the 24 volt supply exceeds about 100 milliamps, the current limiter transistor TR307 conducts decreasing the bias on the series pass transistor TR306. The decreased bias causes the series pass transistor to reduce its conduction and lower the output voltage, thereby reducing the current. This protects the power supply and components, if a short should occur on the 24 volt line. The 60 volt supply uses a shunt regulator transistor, TR305. The shunt regulator reference is the 24 volt supply. A 0.5 amp fuse is used in the primary of the power transformer to protect the power transformer and circuits of the SM152. Two pilot lamps located in the tuning drum illuminate the dial and also act as a pilot light.

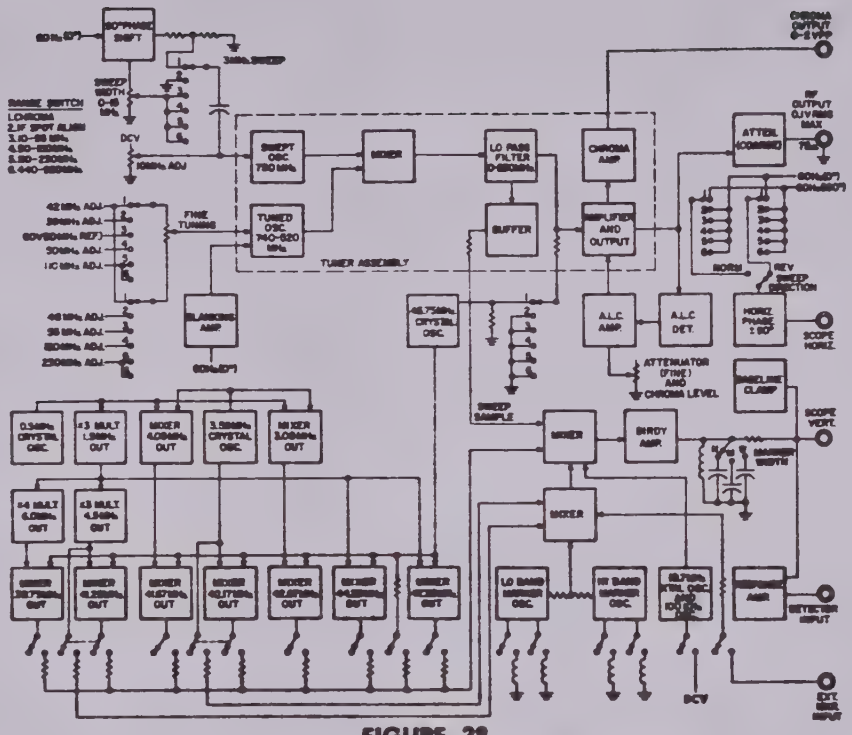


FIGURE 38

SM152 SWEEP & MARKER BLOCK DIAGRAM

TROUBLE CHART

If trouble is ever experienced with the Sencore SM152, it can be isolated to a particular section of the unit by observing the sweep signal output through a television receiver and noting if you have a response curve and/or markers on the scope screen, or if markers are missing. This will help isolate the problem to a specific section or circuit in that section.

The Power Supply should always be checked first if any trouble is encountered. If voltages are not correct, the circuits may not function properly and the tuning will be off. The power supply should be checked as follows:

1. Check the 24 volt supply. It should measure 24 volts, plus or minus .5 volts with a normal peak to peak ripple of 30 millivolts maximum. The ripple will be a square wave due to the blanking circuit. When the Blanking switch is depressed, the square wave will disappear and the ripple should be 20 millivolts or less.
2. The 60 volt supply should measure 60 volts, plus or minus 1 volt with a maximum ripple of 50 millivolts peak to peak.

If the power supply is correct and operating at the right voltages, proceed to isolate the problem with the following chart. The transistors and FETS can be checked in the suspected circuit with an in-circuit transistor tester such as the Sencore TF151.

TROUBLE	CAUSE AND ACTION
Dial frequency off	Reset FREQ CAL on rear of SM152. See section on Internal Adjustments.
No Response curve but all markers visible.	If no RF output can be measured with RF voltmeter, the ALC circuit, RF amp, (TR206) or RF Out (TR207) can be defective. If an RF Output can be measured with RF voltmeter, check the 39G23 probe and TR304.
No Response curve or markers	The UHF oscillators TR201 or TR202 not working. Check with field strength meter on UHF for radiation pickup, or check output with RF voltmeter and pickup loop. If UHF oscillators working, check TR309 with transistor tester.
Response curve, but no markers	Check sweep sample connection on tuner, may be loose. TR203, TR302, or TR303 may be defective. Check transistors and circuits.
No blanking	CR301 is shorted or TR301 is not conducting.
No IF markers, but Chroma, RF and FM markers all good.	TR107, the 45.75 crystal oscillator not working. Check transistor and circuit.
Weak Marker or markers	See calibration instructions under Internal Adjustment section of manual.

TROUBLE	CAUSE AND ACTION
One or more markers missing.	Check diodes and transistors with tester and transformers with ohm meter for each marker as follows:
39.75	Check CR101, TR103, and T101
41.25	Check CR102, TR104, and T102
41.67	Check CR103, TR105, and T103
42.17	Check CR104 and T104
42.67	Check CR105, TR106, and T105
44.25	Check CR106 and T106
47.25	Check CR107 and T107
No Chroma markers on Chroma or IF bands	Check TR108 with transistor tester. Check circuit with meter for defective component.
45.75 and 42.17 markers only visible.	Check TR101 and associated circuit
39.75, 41.25, 44.25 and 47.25 markers missing.	Check TR102 and associated circuit
Channels 4 and/or 5 markers missing.	Check TR109 and associated circuit
Channels 10 and/or 13 markers missing.	Check TR110 and associated circuit
No FM markers.	Check TR111 and associated circuit
10.7 FM markers OK but no 100KHz limit markers.	Check TR112 and associated circuit
Baseline noisy or hashy.	Check and repeak all marker transformers

Spurious Markers

Some spurious markers may appear on the response curve when using the Sencore SM152. There are several possible sources of these spurious markers, but they are easily distinguished from the true markers in the SM152. A rather large birdie marker may appear around 720 MHz in the UHF band and one around 180 to 190 MHz in the 110 to 230 MHz band. The spurious marker will be narrower in width than the real birdie marker. The spurious marker will also tune across the scope trace at a different rate than the real marker when the TUNING dial is slowly rotated. The spurious marker will generally move faster than the real marker. If you are not sure whether the marker is a desired marker or not, turn off all the markers on the SM152. Any marker then left on the screen is a spurious marker. You can also turn the marker you are interested in off and on by simply depressing the marker button a few times and noting where the correct marker is located.

SERVICE AND WARRANTY

You have just purchased one of the finest sweep marker generators on the market today. The SM152 has been inspected and tested twice at the factory to insure the best quality instrument to you. If something should happen, the SM152 is covered by a standard 90 day warranty as explained on the warranty policy enclosed with your instrument.

For the best service on out of warranty work, send the SM152 directly to the factory service department. Be sure to pack the instrument well and insure it in case it is damaged in shipment. Do not ship the unit back in the display carton alone. An outer carton should also be used and a resilient packing material used around the SM152 to prevent any possibility of damage. It is best not to return the unit via parcel post unless absolutely necessary.

To speed up the service on your SM152, be sure to include a note stating the nature of your problem, such as "No RF output on IF Spot Band". If you are returning the unit for calibration only, please state this.

If you wish to repair your own SM152, we have included a schematic, parts list and trouble chart. Any of these parts may be ordered directly from the factory service department.

We reserve the right to examine defective components before in warranty replacement part is issued.

SENCORE
NO. 1 MANUFACTURER OF ELECTRONIC MAINTENANCE EQUIPMENT
3200 SENCORE DRIVE, SIOUX FALLS, S. DAKOTA 57107

NO. 1 MANUFACTURER OF ELECTRONIC MAINTENANCE EQUIPMENT

SENCORE

MODEL SM152
SWEEP & MARKER
SCHEMATIC AND PARTS LIST

426 SOUTH WESTGATE DRIVE, ADDISON, ILLINOIS 60101

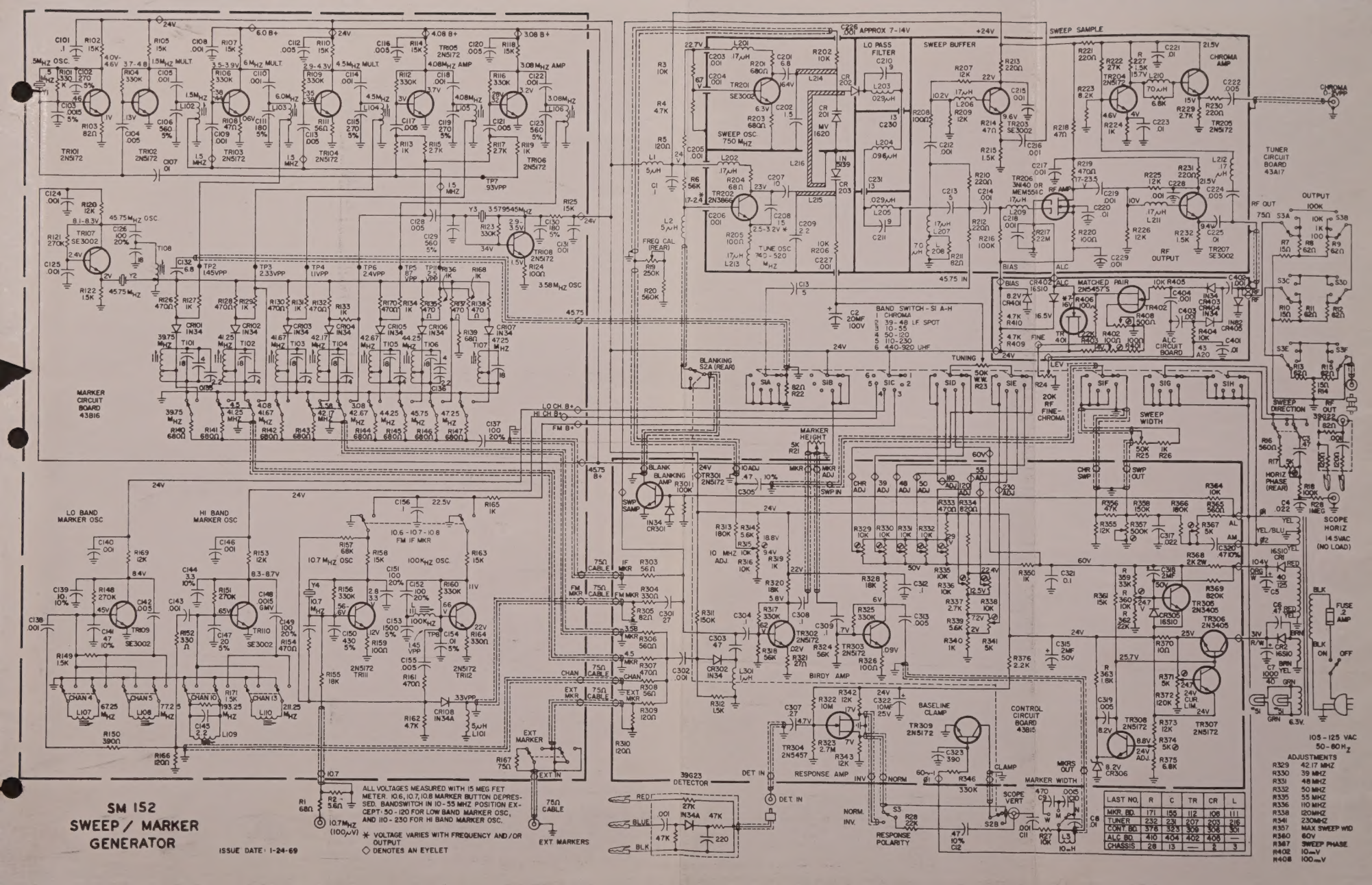
SM152 PARTS LIST

REFERENCE NO.	PART NO.	DESCRIPTION	PRICE
R368	14G251	2K WW 2W 5%	$ .30
R8, R9, R11, R12, R13, R15	14G321	62 OHM 1/2W 5%	.30
R7, R10, R14	14G322	15 OHM 1/2W 5%	.30
R17	15G39	5K Lin Tab Mount	1.50
R19	15G27	250K Lin Tab Mount	1.50
R21	15A41B	5K Lin Panel Mount	1.50
R23	15A71	50K WW Panel Mount	2.25
R24	15A31	20K Lin Panel Mount	1.50
R25	15A72	50K Log Panel Mount	1.50
R315, R329, R330, R331, R332, R335, R336, R338, R360	15A53	10K Lin PC Vert. Mt.	.75
R341, R367, R371, R374	15A61	5K Lin PC. Vert. Mt.	.75
R357	15G57	500K Lin PC Vert. Mt.	.75
R402	15G77	100 OHM Lin PC Vert. Mt.	.75
R408	15G54	500 OHM Lin Vert. PC Mtg.	.75
CR1, CR2, CR402, CR305	16S10	.5A @ 400 PIV Rectifier	1.50
CR101, CR102, CR103, CR104, CR105, CR106, CR107, CR108, CR301, CR302, CR403, CR404	19G13	1N 34A Diode	.50
CR306, CR401	19G18	8.2V Zener Diode	1.35
CR201	50G4	Varicap Diode MV1620	3.00
CR202, CR405	50G6	Diode IN82A	1.50
CR203	50G5	Varicap Diode IN5139	6.00
TR101, TR102, TR103, TR104, TR105, TR106, TR108, TR111, TR112, TR204, TR205, TR301, TR302, TR303, TR307, TR308, TR309	19G29	Transistor 2N5172	.50
TR107, TR109, TR110, TR201, TR203, TR207	19G31	Transistor SE3002	1.50
TR202	19G32	Transistor 2N3866	4.00
TR206	19G34 or 19G36	MOSFET 3N140 MOSFET MEM554C	4.50 4.50

REFERENCE NO.	PART NO.	DESCRIPTION	PRICE
TR304, TR401, TR402	19G35	FET 2N5457	$ 1.25
TR305, TR306	19G33	Transistor 2N3405	2.00
C4, C317	24G195	.022 MF 10% Mylar	.25
C5	24G197	40 MF @125VDC Lytic	1.00
C102, C115, C119	24G79	270 PF 5% Poly	.25
C103, C153	24G191	.0015 MF 5% Poly	.25
C106, C123, C129	24G141	560 PF 5% Poly	.25
C7	24G139	1000 MF @40VDC Lytic	2.00
C111, C130	24G175	180 PF 5% Poly	.25
C139, C207	24G86	10 PF 10% NPO Disc	.25
C3, C6, C12, C305, C320	24G146	.47 MF 10% Mylar	.60
C141, C303	24G192	47 PF 10% NPO DISC	.25
C150	24G131	430 PF 5% Poly	.25
C154	24G183	.01 MF 5% Poly	.25
C202, C208	24G132	1.5PF 10% NPO DISC	.25
C204, C206	24G198	.001 MF Feed Thru	.25
C210, C211	24G193	9 PF 5% NPO DISC	.25
C230, C231	24G194	13 PF Feed Thru	.25
C213	24G153	5 PF 10% NPO DISC	.25
C203, C205, C226, C227	24G148	.001 MF Feed Thru	.25
C315, C318	24G196	2MF @50 VDC Lytic	.35
L1, L2, L101	46G6	5 uh Coil	.30
L3	46G9	10 mh Coil	1.00
L102	46A34	1.5 MHz ADJ Coil	1.00
L103, L104, L105, L106	46A35	3.08, 4.08, 4.5, & 6 MHz Adj Coil	1.00
L107, L108	46A30	LOW RF ADJ Coil	1.00
L109, L110	46A36	HI RF ADJ Coil	1.00
L111	46G11	100 KHz ADJ Coil	1.00
L201, L202, L206, L207, L209, L211, L212, L213	46A26	.17 uh Coil	.30
L203, L205	46A37	.029 uh Coil	.30
L204	46A38	.096 uh Coil	.30
L208	46A31-1	70 uh ON 18K Coil	.60
L210	46A39	70 uh ON 6.8K Coil	.60
L301	46G19	5 uh Coil	.30
T101, T102, T103, T104, T105, T106, T107, T108	28C28	45 MHz Transformer	1.50

REFERENCE NO.	PART NO.	DESCRIPTION	PRICE
Y1	47G5	.5 MHz Crystal	$10.00
Y2	47G7	45.75 MHz Crystal	6.00
Y3	47G	3.579 MHz Crystal	5.00
Y4	47G8	10.7 MHz Crystal	6.00
	28C37	Power Transformer	6.00
	36G15	75 OHM Coax Jack	1.00
	SC8C1	Front Panel	8.00
	8A2	Bezel	1.00
	63A1	Window	.50
	10C241	Case Complete	18.00
	39G22	Matching Pad	5.95
	39G23	Detector Probe	7.95
		RF Cable	1.50
		Shielded Cable with Phono Plug	1.25

(PRICES SUBJECT TO CHANGE WITHOUT NOTICE)



SM 152
SWEEP / MARKER GENERATOR

ISSUE DATE: 1-24-69

ALL VOLTAGES MEASURED WITH 15 MEG FET METER. 10.6, 10.7, 10.8 MARKER BUTTON DEPRESSED. BANDSWITCH IN 10-55 MHZ POSITION EXCEPT: 50-120 FOR LOW BAND MARKER OSC., AND 110-230 FOR HI BAND MARKER OSC.

✳ VOLTAGE VARIES WITH FREQUENCY AND/OR OUTPUT

◇ DENOTES AN EYELET

LAST NO.	R	C	TR	CR	L
MKR. BD.	171	155	112	108	111
TUNER	232	234	207	203	216
CONT. BD.	376	323	309	306	301
ALC BD.	410	404	402	408	—
CHASSIS	28	13	—	2	3

ADJUSTMENTS

R329	42.17 MHZ
R330	39 MHZ
R331	48 MHZ
R332	50 MHZ
R335	55 MHZ
R336	110 MHZ
R338	120 MHZ
R341	230 MHZ
R357	MAX SWEEP WID
R360	60V
R367	SWEEP PHASE
R402	10 mV
R408	100 mV

105-125 VAC 50-60 HZ

ACCOPRESS®

NO. 2507

BF-RED	BL-GOLD
BG-BLACK	BO-PALM GREEN
BD-LT. GREY	BX-EXECUTIVE RED
BP-LT. GREEN	BR-BROWN
BU-LT. BLUE	BA-TANGERINE
BY-YELLOW	BB-ROYAL BLUE

SPECIFY NO. & COLOR CODE

ACCO INTERNATIONAL INC.
CHICAGO, ILLINOIS 60630